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THE FOUNDRY

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702 Pure Ceylon Plumbago

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All orders shipped promptly, car loads or less—from our Pittsburg factory—Sea Coal Facing ground fine and uniform. Prices guaranteed.

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Don't use a filler—Use the genuine article.

Fills blow-holes, cracks and other imperfections in iron or steel castings. Same color and hardness as casting itself. Stays there forever and becomes part of the casting. Makes steam, water, gas, and air tight joints. Send for free sample.

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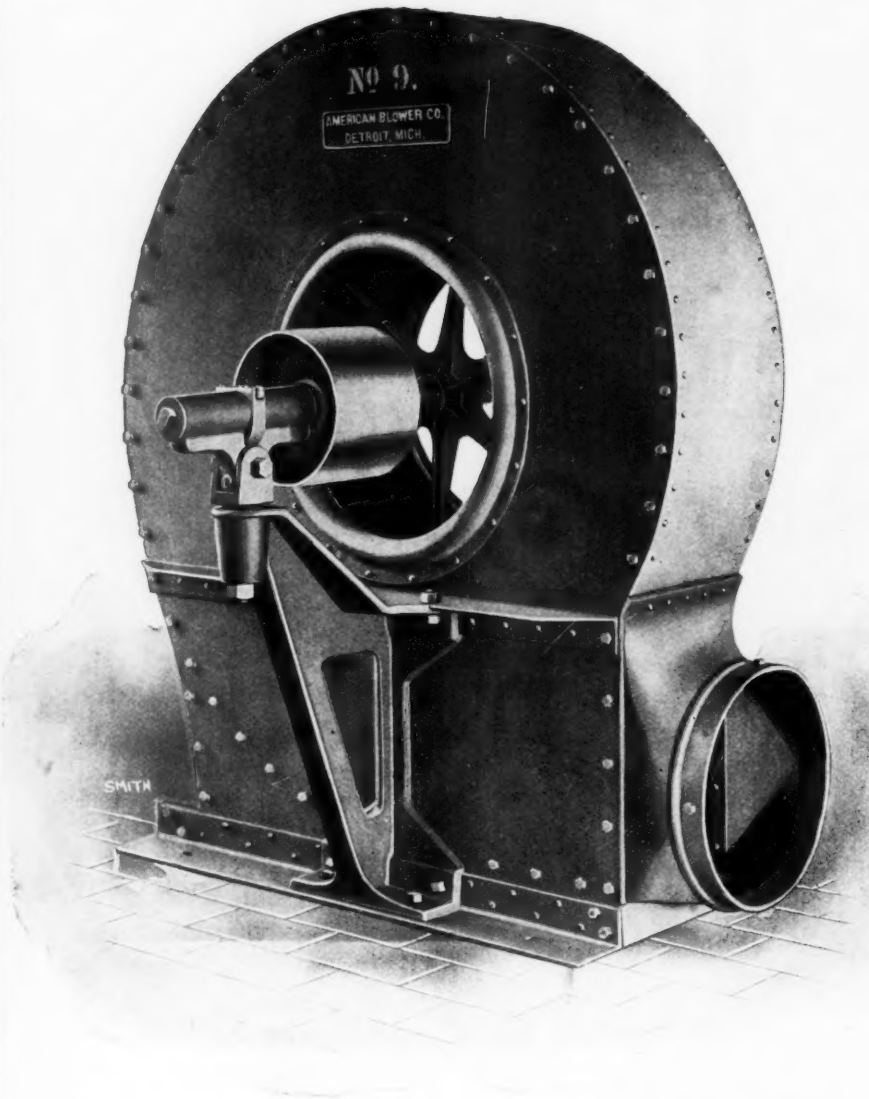

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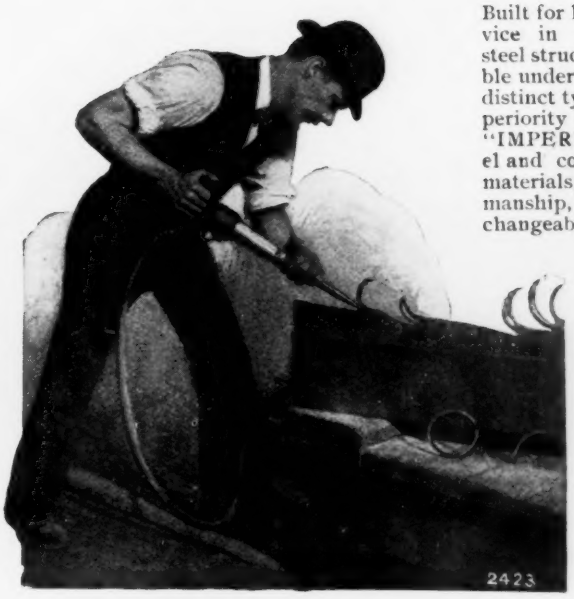

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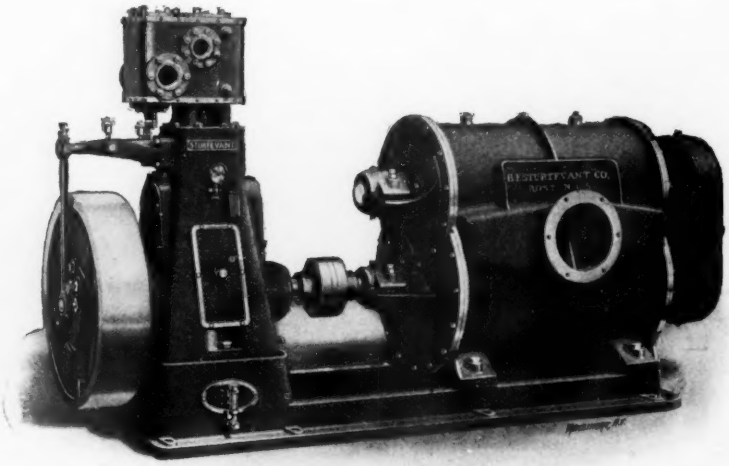

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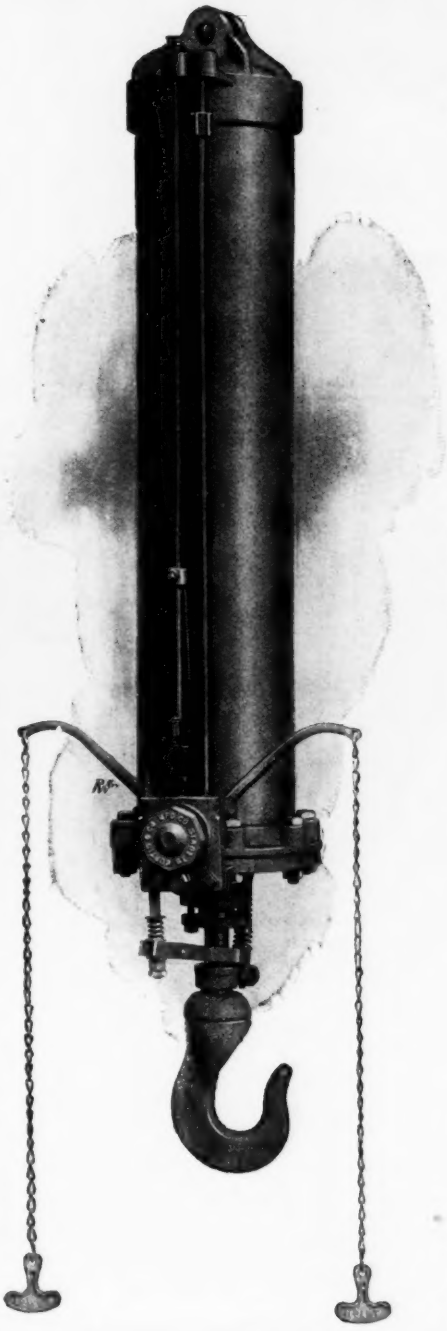

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Will Handle the Most Difficult Moulding

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"That's what they are,—out of order half the time—just when you are busiest away they go—I've had enough I tell you!"

Gee, but he was mad.

And is there anything more exasperating than a poor elevator?

Have you been noticing that all the big hotels and department stores have had enough and are getting back to hydraulic elevators?

Here's the greatest Hydraulic Elevator the world has ever seen. Especially designed for Foundries and Iron Works.

Will stand the raps.

And it virtually does not cost anything to run this elevator. That's what makes folks wonder.

We are making Steam-Hydraulic Elevators in larger numbers for the principal concerns all over the land, and we would like to have you know the machine also.

If you will send and get our circular (no drummer is attached to it—we don't drum) you will find out something of what it means to

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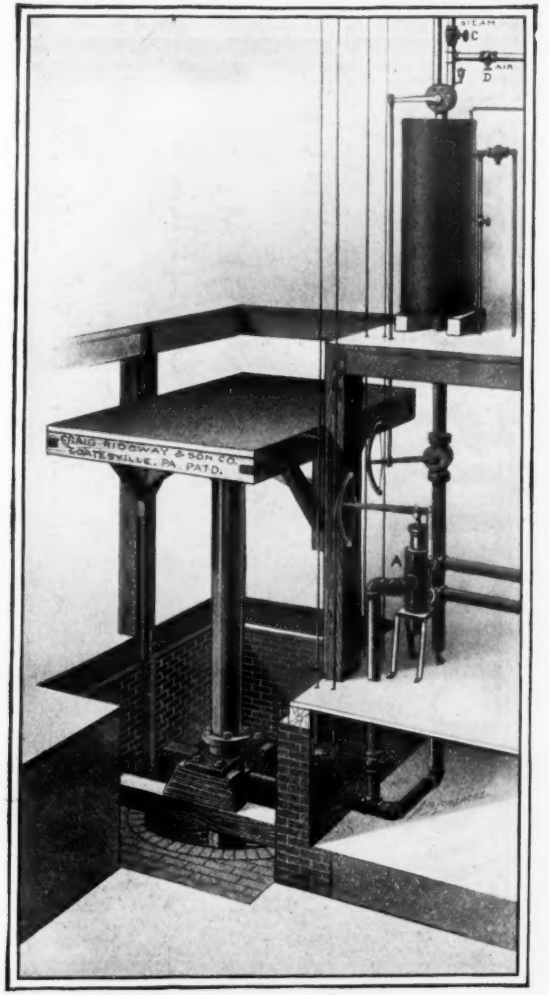

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The Sherwin Core Machines

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Number three the popular size

Makes cores from half inch to three inches in diameter.

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Special shapes made to order.

Conveyor Screws cast and hardened or provided with steel points.

Quick method for die changing.

Protective Shields for Gears.

Large Sand Pan and Hopper.

Cut Gears - Heavy Balance Wheel with pulley attached.

Write for Price - Range of Sizes and full Particulars.

2" Sand Core seven feet long.
No rods—Vented end to end.

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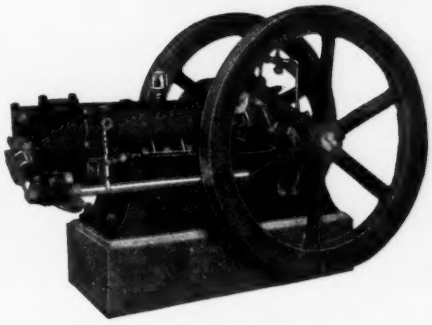
Four Cycle Type---Five to twenty-five horse power.

All modern features combined.



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Only one packed joint under pressure.

Cylinder head and valve boxes cast in one piece.

The most perfectly water jacketed engine on the market.

Vertical steel valves.

Noiseless spiral gears. Phosphor bronze bearings.

New pendulum type governor adjustable in any direction.

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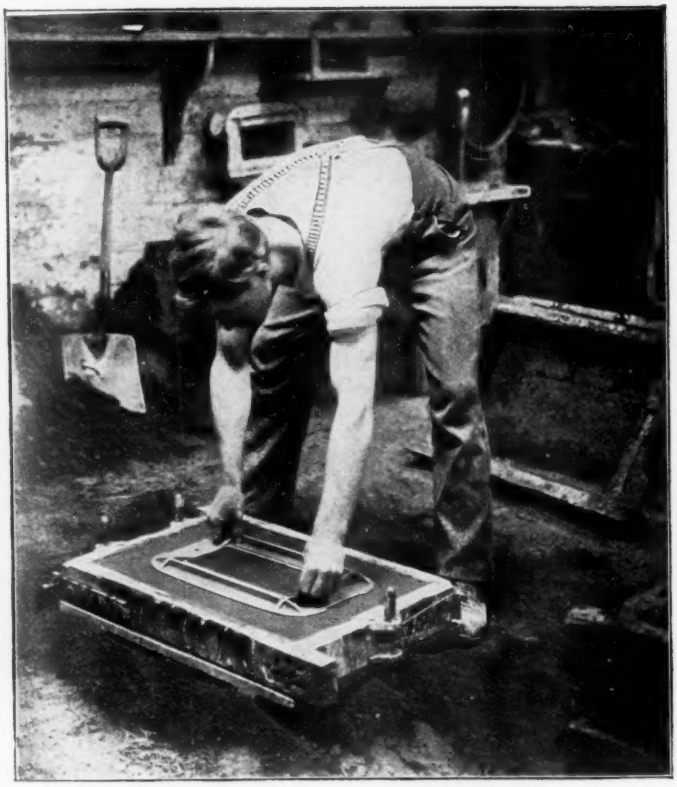

DIXON'S GRAPHITE FACINGS

cover the entire range of Foundry needs for light and heavy work in green or dry sand molds.

For all-around work, where several different facings are not absolutely required, DIXON'S

No. 2441 and No. 6726

ARE THE VERY BEST OBTAINABLE

WRITE FOR FREE TEST SAMPLES AND CATALOGUE 51.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J.

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for General Foundry Use

DON'T SCREEN YOUR SAND WITHOUT IT.

SMALL TRIPOD SHAKER

THIS type of machine is found very convenient and useful for general floor work on account of its portability and the fact that it will screen all the sand which one man can continuously shovel into it.

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The Basis of Good Castings

We have some for immediate shipment.

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There's Always a Best. In Pig Iron It's Pioneer.

A high quality iron that's always soft, strong, uniform and clean. Used everywhere by foundrymen who want money-saving results. Only carefully selected ores and fuel from our own mines and ovens used in its manufacture.

Cut out the loss from defective castings— use Pioneer.

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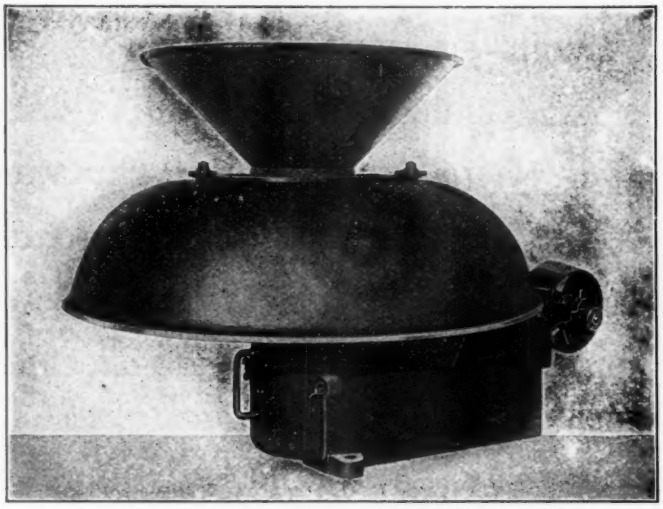
Modern Machine Tools

We illustrate hereunder one of our specialties for Foundry use, which has proved very satisfactory and profitable in service.



Centrifugal Sand Mixing Machine

We have furnished these machines to many users and shall be pleased to supply full particulars upon application.

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Improved Injectors for Boiler Service

SHAFTS, HANGERS, PULLEYS, COUPLINGS, Etc.

FOR THE TRANSMISSION OF POWER.

This trade mark stands for the acme of crucible uniformity.

No better made. The best is none too good. We spare no expense in giving the trade the best that high grade material -- long experience, and careful workmanship can produce.

A trial will convince you.

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Crucible-making has engaged our entire thought and labor for 35 years. This partly explains why McCullough-Dalzell Crucibles lead all others.

Send us an Order.

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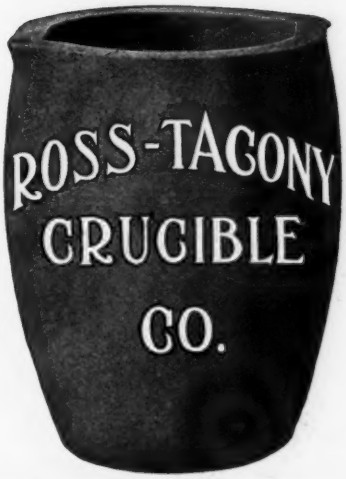
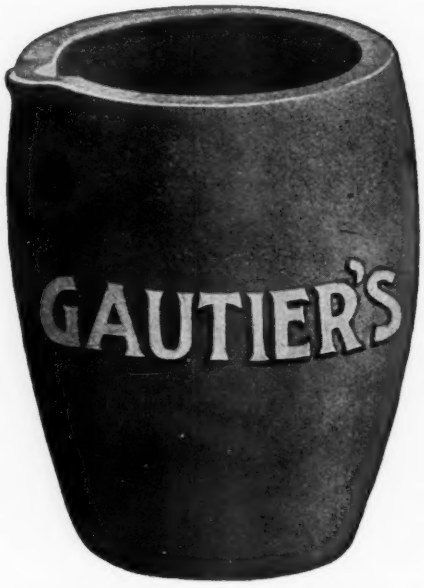


Memorize the name. It will be useful when you need the best there is in Crucibles.

SEND YOUR ORDERS TO TACONY, PENNA.

The Crucible of Satisfaction



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in foundries everywhere
for more than
fifty years

J. H. Gautier & Co.

JERSEY CITY, N. J.

BEST BY TEST

The Core Binder You Need

Holland Liquid Core Compound

Gives Perfect Satisfaction in Coke Ovens and Steam Ovens.

None More Popular.

THE CORES ARE:

Hard **Blow Proof**

Open **Smokeless**

Porous **Moisture Proof**

Strong both green and dry:—Rotten after casting has cooled.

THE CASTINGS ARE

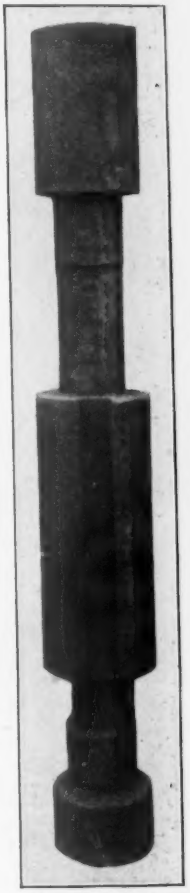
Perfect **Smooth**

True to pattern

Never failures

They are cheapest—Sand can be used over.

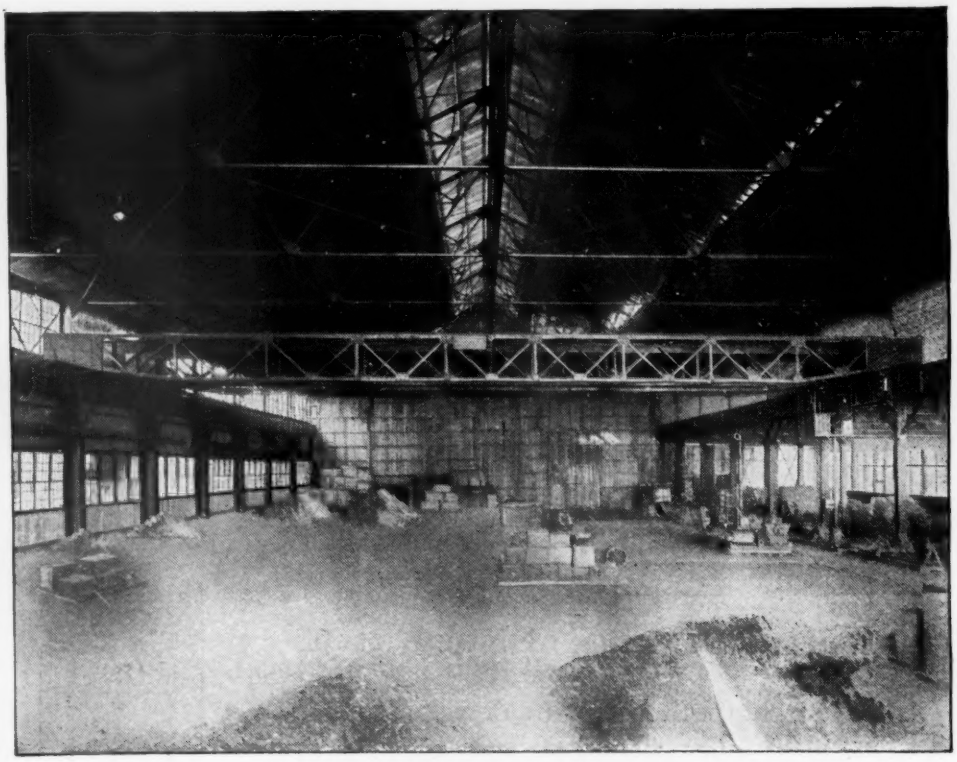
Write for samples and prices at once



Core for Pump Plunger made with Holland Liquid Core Compound

Holland Linseed Oil Company

683-5 Austin Avenue, CHICAGO, ILL.



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CRANES OF ALL KINDS

ENGINEERS, DESIGNERS AND MANUFACTURERS

COMPLETE EQUIPMENT FOR

GRAY IRON, CAR WHEEL AND PIPE FOUNDRIES

MALLEABLE AND STEEL CASTING PLANTS

ALL TYPES

Catalog "F" on request

OVER 1500 IN USE

Awarded Gold Medal for Cupolas and Cranes at World's Fair St. Louis 1904.

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GENERAL OFFICE AND WORKS: HARVEY, ILL., U. S. A. (CHICAGO SUBURB)

THE FOUNDRY

Vol. 28, No. 3. *CLEVELAND, OHIO, MAY, 1906.* *Whole No. 165*

Foundry Department of the Ingersoll-Rand Co. Phillipsburg, N. J.

The product of the Ingersoll-Rand Co. varies from exceedingly heavy compressor units to pneumatic hammers and similar tools, and hence, the design of a plant for constructing this varied line, presents a number of engineering problems not to be found in the design of an ordinary factory. The plant as now laid out is as nearly perfect as modern engineering science can make it. The site selected is on the ground overlooking Phillipsburg, N. J., which is just across the river from Easton, Pa., where the works built some ten years ago are located. The land comprises 200 acres situated 200 feet above the river level, and where exceedingly good railroad facilities can be obtained. The high elevation insures good drainage and freedom from flood troubles. The eighteen buildings are provided with an abundant water supply, good light, room for trackage, and also for future addition to the shops. In laying out the plant a number of factors were taken into consideration. It was recognized that the foundry was a separate department, and should be so located as to enable the work in this department to be carried on with a maximum of efficiency. To facilitate the handling of pig iron, coke and other materials, the foundry floor is placed 18 feet below the level upon which the main shops are located. The foundry department will be considered in detail later.

EXTERIOR OF FOUNDRY.

In laying out the manufacturing department, it was recognized that there were two radically different classes of machines or equipments to be taken care of, but both classes must be shipped. Hence, the shipping room forms the connecting link from the ends of which the manufacturing departments radiate. These departments are separated by a space which gives ample room for the power plant, blacksmith shop, oil treating department and testing room, as these latter have to do with both of the regular manufacturing departments. The construction is such that each department can be extended indefinitely without interfering with the other, as can be seen by referring to the ground plan of the works.

Transportation Facilities.

For moving material from one build- to another, about the yard, and for general transportation purposes, the company has 4½ miles of standard gauge track which connects with spurs of the Delaware, Lackawanna & Western R. R. and the Central R. R., of New Jersey. No narrow gauge railroad system is used, and hence, there is no danger of grade crossing accidents between the narrow and standard gauge systems. All of the handling of supplies in the buildings proper, is carried on either by means of the standard gauge tracks or cranes. In the manufacturing department the traveling cranes are so arranged that work may be passed from one to another throughout the entire plant. The crane arrangement in the compressor erecting shop is typical of the system. The ends of the crane run-ways in the two parts of the machine shop enter the erecting shop on one side, while the run-way for the crane extending through the shipping department enters at one end of the erecting shop. The crane in the erecting shop passes over the ends of the run-ways from the other departments. By this arrangement material can be brought from either of the machine shops into the erecting shop and delivered under the erecting crane. The finished machines can also be delivered by the erecting crane to the traveling crane in the shipping department. Similar arrangements have been made in all of the other departments.

The Foundry.

As already stated the foundry department with its auxiliary buildings stands on a level 18 feet below that upon which the main works stand. The foundry building is 195 feet wide and 500 feet long. It is built of steel and brick construction, with a slag roof.

MAIN BAY OF FOUNDRY.

The central bay is 65 feet wide and is spanned by four 20-ton electric traveling cranes. There are also a number of five-ton auxiliary traveling wall cranes which are electrically driven and operated. In the side bays are located four electric cranes, two on each side. One of the cranes in the west bay is provided with an extension which can be run under the run-way of the cranes in the central bay, so as to pick up a ladle of iron in the central bay and carry it to any point in the side bay.

The foundry floor is divided into several parts, devoted respectively to machine molding, green sand molding and loam molding. The central bay is devoted to the heavy work. The molding machine department is situated in the west bay, which is opposite the cupolas. A portion of the east bay is also devoted to light molding, and includes cylinders for the smaller sizes of air compressors. The cupolas are arranged in two groups of two each

so placed as to divide the length of the foundry into three practically equal divisions. Between the cupola charging platforms is situated the core department which is equipped with eight large ovens 18 feet x 12 feet and 14 feet high. The doors of these ovens are of steel and are provided with a vertical lifting mechanism operated by hydraulic cylinders. Either coal or oil may be used as fuel. In addition there are two small core ovens situated near one end of the foundry. About one

FOUNDRY STORAGE BINS.

hundred boys are employed in the core department.

The foundry office is situated near the center of the foundry and opposite the cupola. At one side of the office is located a sand storage department where a portion of the sand is kept.

The iron melting equipment consists of four cupolas; one a Whiting with an 86-inch shell lined down to 66 inches, and three Colliau cupolas, one 66 inches inside of the lining and the other two 60 and 48 inches respectively. Blast for these cupolas is supplied by Green-Baker blowers geared to electric motors. The blowers for the larger cupolas are driven by 65-horsepower General Electric motors, while the smaller blowers are operated by a 50-horsepower and a 30-horsepower Crocker-Wheeler motor. The metal is conveyed from the cupola to the foundry by means of a transfer truck on a standard gauge track aided by the various cranes.

One of the most important features in connection with the melting equipment is the storage yard, which is located on the same level as the main buildings of the plant, there being two bridges across which the iron, coke and limestone are trucked to the charging platforms. The foundry storage yard for pig iron, coke, etc., is situated on top of a set of concrete bins which are used for the storage of molding sands, fire clay and similar supplies. These bins together with the bridges connecting the storage yard with the foundry are plainly shown in one of the accompanying illustrations which were taken during the construction of the foundry and before the equipment was put into commission. This arrangement brings the sand and supplies used on the molding floor on a level with it, thus reducing the work of handling.

The Brass Foundry.

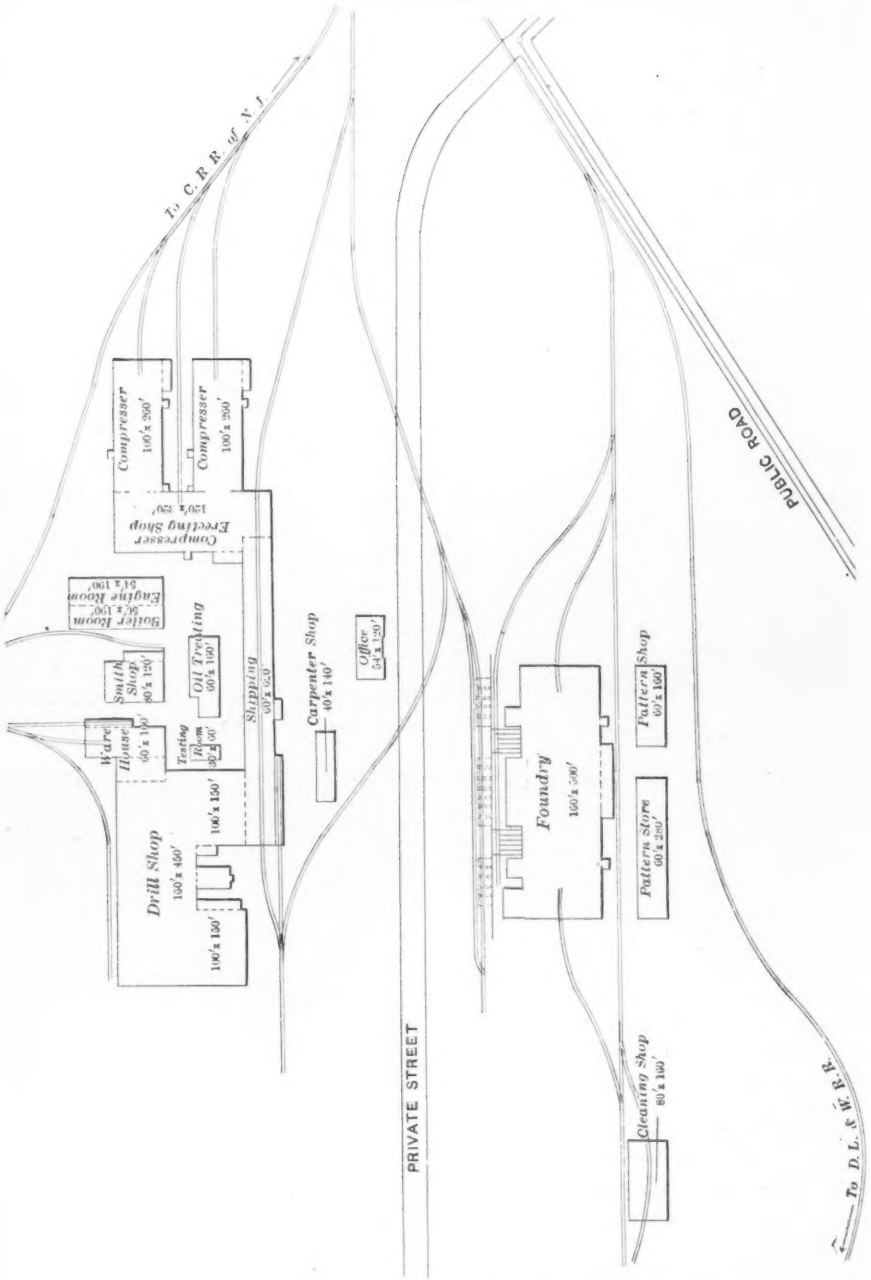
The brass foundry is located in the east bay at one end of the main foundry. The metal is all melted in two 42-inch Swartz furnaces using oil fuel. The cores for the brass department are also made in the regular core room.

BRASS FOUNDRY.

The most of the work is put up by hand in snap flasks or in regular standard iron flasks used for this class of work.

Flask Storage.

The storage and handling of heavy flasks and rigging has been taken care of very simply and efficiently by arranging a ten-ton traveling crane with a span of 50 feet, which covers the space between the foundry and the pattern storage and pattern shop. This is clearly shown in one of the illustra-



PLAN OF INGERSOLL-RAND WORKS.

tions, which also shows the lean-to which contains the foundry office. A standard gauge railroad track extends the entire length of the flask yard and serves for transporting rigging to and from the foundry.

Pattern Shop and Pattern Storage.

The pattern shop and pattern storage are located opposite the foundry building both being of what is commonly called New England mill or slow burning construction. The pattern shop is 60 x 160 feet, and the lower floor is divided into two divisions one of which is devoted to the making of flasks and the other used for heavy pat-

tern work. All three of the departments are fully equipped with wood working machinery. The glue pots used in the pattern shop are electrically heated and all of the labor saving devices found in most of the modern pattern shops have been introduced. About thirty pattern makers are regularly employed.

The pattern storage warehouse is situated immediately north of the pattern shop. This building is three stories in height, 60 feet wide and 280 feet long and is also of slow burning construction.. There are six fire walls which divide each floor into seven compartments. The openings through the fire walls are closed by automatic fire doors held open by fusible connections. The floors are constructed of two layers of heavy planking separated by a layer of 3/8 of an inch of asbestos. Both the pattern shop and the pattern storage room are equipped with sprinkler systems for fire protection.

The pattern shelving is of wood, the shelves being made of narrow strips which would allow the sprinkler system to reach all parts of the shelving, and thus greatly increase its efficiency in case of fire. The patterns are all recorded in a suitable card index system by which the man in charge keeps track of each individual pattern.

FLASK STORAGE YARD.

Chipping and Cleaning.

To make provision for the enlargement of the plant by extending both the pattern storage and foundry to the north, and also to remove the dust incident to cleaning as far as possible from the foundry, the cleaning room has been located several hundred feet north of the foundry. It is on a line with the pattern storage and pattern building, and will form one of the buildings in that series when the plant is extended northward a sufficient distance. The building proper is of steel and brick construction 80 x 160 feet and is divided into a 40-foot center bay and two 20-foot side bays. The rough castings are brought from the foundry to the center bay by cars on the standard gauge track. They are then shifted to any required place by means of two 20-ton cranes in the main bay. The side bays are also equipped with hand operated cranes. In addition there is a room for sand blast operations, a set of tumblers, the necessary grinding stands equipped with carborundum wheels, an exhaust system for carrying off the dust, and an equipment of pneumatic chipping hammers.

DAILY CUPOLA REPORT

Date Jan. 9. 1905

	Charge No.	Pig No.1	Pig No.2	Pig No.3	Scrap No.1	Scrap No.2	Shop Scrap	Bad Cast	From Heat of	Remelt	From Heat of	Coke	Total
	1	829	1521			1296		136	Jan. 7	390	Jan. 7	940	4172
	2	820	1464			1218		128	"	387	" "	466	4017
	3	836	1519			1184		142	"	411	" "	472	4092
	Totals	11918	20600			17516		1916		4918		7386	56868

Blast on at 1:10 P.M.	Good Castings	44139	Total Iron Melted 56868
Blast off at 5:20 P.M.	Shop Castings		Deduct Result of Heat 53070
Time of Heat 4 H. 10 M.	Bad Castings	2119	Melting Loss 3798
No. lbs. Iron melted per	Remelt	6812	Percent 6 1/2
100 lbs. Coke 791	Total Result of Heat	53070	Percent Good Castings 95

Remarks:

Foreman

FORM 1—DAILY CUPOLA REPORT.

FOUNDRY COSTS.

BY R. W. MCDOWELL.

A cost system is intended to show the cost of production and not as an aid to making guesses at the cost. If estimates are all that is required, a tablet of scratch paper and a lead pencil should answer the same purpose as the most elaborate cost system that was ever devised.

It is surprising to note the number of

foundries whose cost systems are run with a view of getting a general estimate as to how much the product is costing, and there is no really good reason for this, for if the cost system and the general accounting system are gotten up in such a manner as to work in harmony with each other, it is just as easy to get accurate costs as it is to get estimates.

If the foundry is of any size, however, it will be found far better not to attempt to find daily costs, or rather, not to base the system on this principle. Monthly costs are much easier to determine, and can be found with less clerical labor, owing to the fact that nearly everything else around the plant is run on a monthly basis. Again, the matter of factory and general expense can be put in monthly at its exact cost, taken from the general account books, while it is more or less a matter of guess work when daily costs are attempted, and guess work is something which should be eliminated at all hazards.

The system described here is intended more to meet the requirements of the general foundry than for a plant engaged in any particular line of manufacturing, or one making any special kind of castings. To operate such records as are shown here, the plant should be run in

IRON REPORT FOR MONTH OF January 1905

Kind of Iron	Weight	Per Cent	Total	Price	Extension		Total	
Pig. No. 1	236180	.15 7/8		16.00	1687	00		
Pig. No. 2	387200	.25 5/8		15.25	2638	07		
Pig. No. 3	79820	.05 1/8		13.95	497	08		
Scrap No. 1								
Scrap No. 2	631142	.41 3/8		12.00	3291	83		
Shop Scrap	5964	.00 7/8						
Bad Castings	52811	.03 1/2		15.60	438	35		
Total	1393117	.92 1/2						
Add Remelt	118916	.07 5/8						
Total Iron to Cupola	1512033	1.00 %	1512033					
Total Cost					8550	33		
Good Castings	1259112							
Shop Castings	3622							
Bad Castings (Deduct)	54166				422	49		
Remelt	118916							
Total Results	1435816		1435816		8127	84		
Loss		5%	76217					
Add Cost of Coke, Flux, etc.					202	50	8330	34
Cupola Labor							227	50
Labor Handling Iron							86	10
Cost of Iron to Molder							8643	94
Cost per lb.				.00602	.0060			

FORM 2—MONTHLY IRON REPORT.

DAILY MATERIAL REPORT

Date Jan. 13, 1905

Materials		Source	Quantity	Chk.
Molding Sand	(lbs.)	#1	1169	11
Molding Sand	"	#2	6320	12
Facing	"	A	108	6
Facing	"			
Oil	(gal.)			
Chaplets	(lbs.)		16	19
Limestone	"		400	28
Flux	"			
Fireclay	"		14	2
Other Materials				

J. C. Wilgus
Foreman

FORM 3—DAILY MATERIAL REPORT.

different departments, labor and material used in each department being kept track of separately from the other departments. In an ordinary foundry these departments would be foundry, core room, cleaning, grinding and chipping room, machine shop or finishing department, pattern shop, and office. What practically amounts to another department is run under the head of unclassified labor, composed of men who unload cars, move castings about from place to place, and do all other such work of a similar nature which does not properly come under the direction of any particular department, but is more or less associated with all. Each department should have a distinctive color for the forms in use by it, all forms used by this department being of the same color. This simplifies matters considerably for the office, and prevents confusion and mistakes. The foundry forms may be white, machine shop forms yellow, core room forms pink, etc.

The product should also be classified according to weight or the style of castings. Thus, class A may represent castings of over 500 pounds in weight, class B 300 to 500, class C 100 to 300, etc. This matter, however, would have to be determined by the style and kind of castings that are being manufactured, and this is simply a suggestion, as all that is attempted here is to give a general outline for a cost system adapted to general foundry work.

REQUISITION FOR MATERIAL.

Date Jan. 13, No. 227

To B. R. Dolan Storekeeper

Please furnish the following material to be used on Order No. 586 Turn these requisitions in to the office daily.

Amount	Material	Weight	Check
4	pcs. ½" round iron 3 ft. 6 in.	8 lb.	

This space for office use.

Entered, Stock Record 38

Entered, Cost Records, a. J. G.

J. A. Wilgus.

FORM 4—MATERIAL REQUISITION.

Records of Material.

First in order under this heading are naturally the iron reports and records. These reports are, of course, the most important of any of the records of material, and it is necessary to have them arranged in such a manner as to give full and complete information regarding the iron. Form 1 shows a cupola report which is made up and turned in daily. This is intended to give a full record of the heat, showing the quantities of iron and coke used in each charge and is arranged so that the totals of each separate kind of iron are easily obtained. To insure any accuracy in the mixture of the iron as well as in the cost records, it should be insisted upon from the very start that the utmost care is to be exercised in the weighing and reporting of the various kinds of iron, and that no guess work whatever will be tolerated. Each charge should be carefully weighed, and should immediately be recorded upon a blackboard ruled off in a manner somewhat similar to the upper portion of the form shown. Unless this is rigidly enforced, there will be little use in trying to run an accurate cost system, for if the iron reports are not strictly accurate in every particular, the balance of the system will be completely thrown out, and the system itself will be worse than useless.

Space is provided at the lower part of the report for information of a general character concerning the heat, also for any remarks necessary. The time of the heat, number of pounds of iron melted per pound of coke, results of heat and melting loss are all shown, part of this information being reported from the foundry and the remainder being fig-

ured up in the office. The columns headed "From Heat Of" are provided for the purpose of showing where the

RECORD IN lbs OF Nos. 2 Pig FOR MONTH OF January 190 5

Where Kept 101-106 Grade B Minimum Normal Sheet No. 12

Date	Order No.	Weight	Total	Date	Report No.	Weight	Total	Date 1905	Weekly Balance	Balance
1			46498	1				Jan. 2		46498
2				2	1	38700				
3	924	96810		3	2	21100				
30		114694	114694		25	18690				
31				30	26	22500	886900	31		1819112
Totals		5226145	5691112	31		387200	3872000			
Deduct			387200							
Balances			1819112							

FORM 5—IRON RECORD

remelt and rejected castings should be credited in cases where it is impossible to get these items in shape for melting in the following heat. This should not be allowed to happen any oftener than is absolutely necessary, but it is a matter that will sometimes happen, and these columns are designed to prevent confusion at the times when this occurs. In this connection it might be mentioned that it is imperative in cases of this kind never to allow these two items out of different heats to become mixed, as there would be no way of obtaining the melting loss should this occur.

The melting loss and the percentage of good castings should also be carefully kept track of for future reference, as it is by comparison of items of this kind that the weak spots in the foundry methods are found out, and measures taken for their betterment. Melting loss is figured on the total charge, and the percentage of good castings is figured upon the total weight of all castings, good and bad. The reports shown here are used by the clerks who look after the stock records as well as those who make up the cost record after which they are filed in a binder in such form as to be readily referred to at any future time. An index tag slipped on the report for the first day of each month makes reference easy. It is a good plan to refer to these reports day by day and compare the various heats thus keeping informed as to whether or not they are running regularly.

At the end of the month, the monthly iron report, Form 2, is made up from the daily cupola reports. The total weight of each kind of iron that has been used during the month is entered, together with the shop scrap and bad castings, and is figured at the cost value. The percentage of each kind is also figured. Remelt is then added to the total weight, but does not figure in the costs for the reason that remelt should run practically the same day by day, and therefore an amount would be added in which would have to be deducted later. The weight of the total results from the heats of the month, including good castings, rejected castings and remelt, is added up and deducted from the gross weight, giving the melting loss for the

CORE ROOM REPORT FOR _____ 190

Batch No.	Sand	Linseed	Core Comp.	Molasses	Flour	Rosin	Sands.	Remarks
1								
2								
Totals								

Names	No.	Kind of Core	No. Made	No. Bad	No. Good	Broken	Delivered	Check
Totals								

Remarks:

Foreman _____

FORM 6—CORE ROOM REPORT.

month, together with the percentage. The weights of the good castings and rejected castings are obtained from the production sheets, which will be described farther on. The value of the rejected castings used in the cupola during the month is deducted from the entire cost of iron melted, giving the net cost of iron. The cost of coke, flux, etc., is then added to the net cost of iron together with the cupola labor and the labor of handling the iron, which gives

the cost of the iron as the molder gets it from the cupola. From this amount the cost per pound of the iron may be figured, together with the cost per pound of the iron in the good castings. The latter item is necessary for the purpose of figuring up the cost of separate orders, and should be accurately kept

No. _____

NAME _____

TIME AND PAY CARD.

Month of _____

Total Time _____ Hours

Rate _____ Amount $ _____

Piece Work _____ " $ _____

Total

Deductions _____ " $ _____

Check No. _____ Net Due $ _____

DATE		A.M.		P.M.		
		IN	OUT	IN	OUT	TOTAL
1						
2						
3						
15						
16						

Time First Half Hours _____

" Second Half " _____

Total _____

FORM 7.—TIME CARD.

monthly. When finished, this report is set aside to be used in figuring up the cost sheet, and is afterwards filed.

Cost of Other Materials.

The quantity and weight of material other than coke and iron is obtained from the daily material report, Form 3, and the requisition, Form 4. The material report is turned into the office each day, and great care should be exercised to have all amounts and weights correct. The report is simple in form, being merely a list of the materials which are used in the foundry, with columns provided for the quantities used. Material that is of such form as to be kept in the store room is issued on receipt of a requisition from the foreman, and no material should be delivered without a requisition. The storekeeper also has the oversight and direction of the issuing of supplies, such as brushes, riddles, etc., a requisition similar in form to the illustration being provided for this purpose. All such requisitions are turned over at regular periods to the stock clerk in the office, who enters them up in his records. The stock records of general materials are similar in form to the iron record shown in Form 5. This report gives a record of the quantity of No. 2 pig iron used during the month, one sheet being used for each month. A sheet similar to this is used for each kind of material used. The form shown here is arranged in such a manner as to permit of a balance being shown at any time desired, and to show the amounts used for any given period of time less than a month. As iron is received it is entered up in the columns to the left of the sheet; iron used is entered in the central columns, and balances on the columns to the extreme right. The same applies to the other materials. With some kinds of material which are not frequently used, it may be desirable to use some form of record which will not need to be transferred to another sheet monthly as is of course, necessary with the records shown here.

Instead of following out the usual custom of taking stock yearly, the plan is advocated of taking an inventory of any particular material that happens to run low at any time, no matter what time of the year or month this happens. When the regular account books are to balance at the close of the year, the amount of material on hand can be taken direct from the material records. This plan

Foundry PAY ROLL FOR MONTH OF January 1905

Department Letter a Foreman J. McGilvra

No.	Names	Sun. 1	Mon. 2	Tues. 3	Wed. 4	Thur. 5	Fri. 6	Sat. 7	Sun. 8	Mon. 9	Tues. 10	Wed. 11	Thur. 12	Fri. 13	Sat. 14	Sun. 15	Hours	Rate	Day Work Non. Pro.	Day Work Pro.	Piece Work	Total	Deduct	Amount Due
			9 0	9 5	10	10	9 5			2 7 5	2 7 0	2 8 5	2 1 0	2 1 0	3 0 5	3 4 0 5		Base .118 .05			3 4 0 5	3 4 0 5	1 0 0 0	2 4 0 5
3	J. P. Dahlen		2	2	2	3	3	2		2	2	2	2	2	3									
119	M. Stoddard		10	10	10	10	10			10	10	10	10	10	10			17½		1 9 2 5		1 9 2 5		1 9 2 5
126	Lew. Francis		10	10	10	10	10	8		16 2	16 2	15 5	18 0	18 8	18 0			15	8 7 0		1 0 3 0	1 9 0 0	8 0 0	1 1 0 0
87	T. Wiley		26 0	26 5	26 0	26 0	24 0	27 0					26 0	26 5	26 0	33 4 5					2 3 4 5	2 3 4 5		2 3 4 5
7	Morris			10	10					10	10	10						15	10				8 5 0	

FORM 8.—PAY ROLL.

PRODUCTION SHEET FOR January 9th 1905 No. 7

No.	Names	Order No.	Name of Casting	Pattern No.	No. Class	No. Made	No. Bad	No. Good	Ck.	Wt. Each	Wt. Made	Wt. Bad	Wt. Good	Class A No.	Class A Wt.	Class B No.	Class B Wt.	Class C No.	Class C Wt.	Class D No.	Class D Wt.	Class E No.	Class E Wt.	Ck.
3	J. P. Dahlen	119	Back No. 118	118	23	58	3	55	✓	30	1 7 4 0	9 0	1 6 5 0							55	1 6 5 0			
119	M. Stoddard			✓	✓			18		90	1 6 2 0		1 6 2 0							18	1 6 2 0			
126	Francis	110	Plate C	49	25	18		18		32	1 8 5 4	6 4	1 6 0 0											
89	Williams	113	" D	50	23	5 2	2	50			1 2 0 0		1 2 0 0		1 2 0 0									
76	J. Morris	113	Column	1126	a	1		1																
											4 6 2 5 8	2 1 1 9	4 4 4 1	3 9	1 9 2 5		2 4 6 0		4 8 7 2		3 3 1 8 1		1 7 0 0	

FORM 9.—PRODUCTION SHEET.

applies to material and not to finished product, although this latter could be arranged in the same manner.

Department Records.

The records for the other departments outside of the foundry are run in the same manner as the foundry, except that the reports are varied to suit the various kinds of work done in these departments. The core room is sometimes run as a part of the foundry, but will here be considered as a separate department, and a report of material, labor, and product rendered each day. This report is shown in Form 6. It is gotten up on very much the same general style as the cupola report, the upper portion of the sheet being used for a report of the material used in each batch of sand mixed. Linseed, molasses, core compound, flour, etc., are easily measured as issued, and accurately reported, while sand must be weighed and presents more difficulty in reporting. An excellent plan for keeping track of the weight of sand used daily is to have a track from the sand sheds to the core room, running across the scales. All sand should be brought in on a truck holding a considerable quantity, the weight of each load being marked up on a blackboard kept for that purpose, after it crosses the scales. Material not shown in the report is reported from the requisitions on which it is issued.

The lower section of the report is intended to show what the production in the core room has been for the day, and to furnish the timekeeper with proper data for making up his payroll, coremakers being paid by the piece as a rule. Columns are provided in this portion of the sheet for total cores made, number bad, number good, and a column for number broken, as it is the usual custom to pay the coremaker for cores broken through no fault of his. These reports are turned in every day, going first to the timekeeper who enters up the coremakers' time in the payroll, after which they are passed on to the stock clerk and are entered up in the material records.

One copy of the shop order, which will be described later, is made out for the use of the core room, in order to let the foreman of that department know just how many and what kind of cores are required, thus eliminating the chance of overstocking on any particular kind of core.

The machine shop, blacksmith shop and pattern shop are the only other departments using material, and this is all issued on requisitions in the machine and blacksmith shops, so that no reports of materials are necessary. The pattern shop ought to be run and considered as a separate department altogether, as it uses a different kind of material and turns out a finished product of its own, thus being practically a separate factory, although under the same management. For this reason it requires a special set of records for its own use, which records constitute a separate and complete cost system.

Labor.

Labor must be carefully accounted for in order to operate a sucessful cost system. For keeping the time of employes, a time recorder of some description is by far the most desirable method. All employes, whether employed by the day or by the piece, should be furnished with a card similar to Form 7, on which their time of beginning work in the morning and finishing in the evening is automatically recorded. Each of these cards bears the workman's number in large type so as to be easily distinguished from other cards, and all cards issued to this particular workman bear this number. These cards are arranged so that the time of an entire pay period is kept on one card, these pay periods being from the first of the month to the fifteenth, and from the fifteenth to the last day.

The number of these clocks or time recorders necessary will depend on the size of the plant and the number of men employed. If the plant is large enough, a clock may be used in each of the principal departments, but the ordinary sized plant will not require as many, and one clock will conveniently take care of 200 to 250 men. Cards for the different departments are stamped with the name of these departments, and are kept in racks at either side of the clocks when not in use. These racks are numbered to correspond with the numbers

on the cards, each card being kept in the rack of the same number. When a man comes to work in the morning he takes his card from the rack at the left of the clock, records the time, and drops his card in the rack of corresponding number at the right hand side and proceeds to work. The same process is gone through with upon quiting work in the evening. After all the men are at work in the morning, a glance at the racks will show just who is at work and who is absent. The timekeeper takes all the cards from the right hand rack each morning and enters the time in the payroll book, a page of which is shown in Form 8, and which will be described later. When he comes to a card used by a man working by the piece, he merely makes a check mark in the proper space opposite the man's name, to show that he was at work on that day, and passes on to the next card. The time of a day-work man is entered in full in the proper space. This process of entering the cards can be done very rapidly by arranging the cards of the different departments according to the way that the numbers run in the book, and then entering them as they come, a page in the book being devoted to each department, or several pages if necessary.

At the foot of the card a space is provided for a statement of the amount due the user of the card, showing day work, piece work and deductions. These statements are taken around the shop, having been made up several days previous to pay day, in order to correct any mistakes that may have been made. If the card is satisfactory to the workman he signs it, and if there is any dissatisfaction on his part, it will be investigated, and if just, will be corrected before pay day, and the card signed by him. This does away with considerable delay on pay day. This plan was employed by the writer for nearly two years in a foundry with which he was connected, and was entirely satisfactory resulting in quick pays, and far better satisfaction among the men.

Piece work in the foundry and core room is reported by the production sheet, Form 9, and the core room report,

SHOP ORDER

Date January 4th 1905 No. 119

To J. C. Wilgus

Foreman

Please get out the following work, reporting all labor and material under this order number 119

240 Bases, Pattern No. 118

Date	Made	To Date	Balance
Jan. 6	22	22	218
7	56	78	162
9	55	133	107

FORM 10.—SHOP ORDER.

Form 6. The production sheet may be made up from cards turned in by the molder and O. K.'d by the foreman, but a better plan is to have the factory clerk go through the foundry just before the men are ready to pour off in the afternoon and make up a report of what each man has put up, giving the molder, number, name and number of helper and the number and mark of the castings put up. From this report the production sheet is made up in three copies, one daily and is the source from which the amount due coremakers is obtained, and is entered in the same manner. Piece work in other departments is reported by cards similar to those shown in Form 12, which will be described under the heading of the shop order.

When all day work and piece work has been entered up in the payroll book, the amounts are extended to the proper columns and the payroll made up. It will be noted that the "day work" col-

NAME ORDER NO.

ARTICLE Base for emery wheel stand JOB NO

DATE BEGUN Jan. 8, 1905 DATE FINISHED Jan 10. 1905

MATERIAL	WEIGHT	RATE	COST	COST OF MATERIAL	LABOR	HOURS	RATE	COST	COST OF LABOR	TOTAL COST	SELLING PRICE	PROFIT
CAST IRON	120	1-65	1.98	91	FOUNDRY	8@30	2.40	COST	3.80	4.71		
COKE					PATTERN ROOM							
SAND					BLACKSMITH	3 35@20	.72	3.12				
CORE OIL					MACHINE							
FACING					CLEANING							
LIMESTONE					MISC PRO			.68				
LUMBER												
SCREWS												
INCIDENTALS				12								
BRASS												
WROT IRON												
TOOL STEEL												

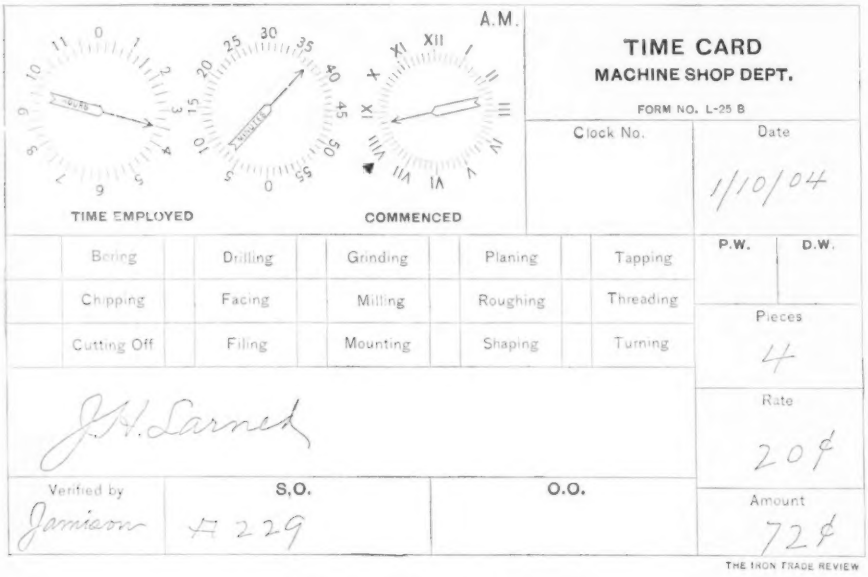
FORM II.—SHOP EQUIPMENT ORDER.

of which goes to the foundry. When entirely completed, one to the weighmaster for convenience in reporting the heat, and one remains in the office. The "class" columns are omitted from the foundry and weighmaster's copies, a column for the percentage of loss sustained by each molder being substituted on the former. As soon as the weighmaster turns in his completed copy, the foundry and office copies are made out, the office copy going to the timekeeper who enters up the amount due each molder in the payroll book. It then is turned over to the stock and cost clerks for entry on their records, thus serving as a time and a stock record. Its functions as a stock record will be discussed under a different heading.

The core room report is also made up

umn is divided into two sections, productive, and non-productive labor, piece work being, of course, productive labor. In this way these two classes of labor are kept separate and distinct at all times, and it is thus easy to figure up the percentage of non-productive labor in a department or for the entire plant, for any period of time. This is necessary for the purpose of getting the cost of a single order or of several orders. This arrangement is also convenient in making up the cost sheet. When a man is changed from productive to non-productive labor, or vice versa, a notation is made to that effect on his card and on the payroll book. The operations necessary for keeping time in the manner here described are much simpler in the operation than they are in the de-

scription, and if the work is carefully performed by one clerk and then checked by another clerk, there is no reason for mistakes. Of course, it is natural that mistakes will come up at times, but they will be few, and if the work is properly checked, they will be caught before any harm has resulted from them. In this connection it is desired to impress on the mind of the reader the extreme importance of checking all clerical work of every description. This applies to all work of a clerical nature whether it is copy for each of the principal departments being made out. Whenever an order is received, a shop order is made out, and the copies distributed to the various departments. The office copy has the form at the bottom which is shown in the illustration, for the purpose of keeping track of the castings made on an order from day to day. It will be noted in the illustration that on Jan. 4 a shop order was issued for 240 bases, pattern No. 118. On Jan 6, 22 of these bases were made, leav-



FORM 12.—LABOR COST RECORD.

done in the office proper or in the factory. And this checking should in all cases be done by a different man from the one who originally performed the work, as one will often fail to notice his own mistakes.

By the operations described above, all labor is recorded and disposed of, with the exception of labor on orders on which separate costs are kept, which class of labor comes under a different heading. This gives the data for making up the cost sheet, with the exception of factory and general expense, but before describing the cost sheet, the shop orders and stock records will be described.

The Shop Order.

Form 10 shows the shop order, a ing a balance of 218. On the 7th 56 were made, a total of 78 to date, and leaving a balance of 162. This is continued until the order is completed, thus keeping the office and the foundry foreman informed at all times as to the number of castings required to complete an order, and preventing the foreman from making more castings than ordered. This is only necessary in cases where there are a large number of castings on an order, on which shipments are being made before the order is completed. In cases where there are several different kinds of castings on one order, similar forms may be provided, one for each kind of casting, and attached to the order and kept track of in the same manner. If desired, this

form may be left on the foundry order instead of the office copy and kept by the foundry foreman himself, but in the opinion of the writer it is better for this work to be done in the office, as it is not a good plan to burden the foremen with any more clerical work than is absolutely necessary.

RECORD IN _____ OF CLASS _____ CASTINGS FOR MONTH OF _____ 190 _____

Made							Shipped					Balance		
Date	Made	Total	Sheet	Wt. Made	Total Wt.	Date	No.	Total	Order No.	Weight	Total Wt.	Date	No.	Weight
1						1						1		
2						2						2		
						3								
30						30						30		
31						31						31		
Total														
Deduct														
Balance														

FORM 13.—STOCK RECORD.

Orders for castings for shop use, such as clamps, iron flasks, weights, etc., are of a similar form, but are printed at the top in large type, "For Equipment." The record of the cost of such orders is kept on a card shown in Form 11. These cards are made out as soon as an order is completed, and are filed according to order numbers. If it is desired to keep track of the separate cost of a customer's order, it may be done in the same manner, a different colored card being used to prevent confusion. These cards are 4 x 6 in size, and are kept in the ordinary card index drawer, separate drawers being used for customers' and equipment orders. The cards are so simple as to require but little explanation, being merely a description of the order, and a list of material and labor. Material on these orders is obtained from the requisitions, the iron being figured at the cost per pound shown by the iron report. Labor is reported on a card like Form 12. As soon as a man is put to work on a job, one of these cards is made out for him and his time recorded upon it. The molder's time can usually be obtained from the production sheet, as most of the molder's work is by the piece. In the illustration the card is designed for use with the Calculagraph, and this form is recommended above others for the reason that it eliminates the part of the clerical work most subject to mistakes,—the figuring of the elapsed time—as the machine does this part of the work automatically. If it is not desired to use this machine, however, the space shown in the form devoted to the stamping of the time may be used for recording the time of starting and finishing the work, in the ordinary manner. If however, it is possible to use the machine, the results are sure to be accurate, and considerable clerical work will be saved. The operations listed on the card may be omitted and a blank space left for noting the operation, if desired. When the workman finishes his part of the work he records his time and puts the card in a rack of the same number as the order, from which the cards are gathered up at intervals and turned into the office, where the value of the time spent is figured up and entered on the other

FORM 14.—COST SHEET.

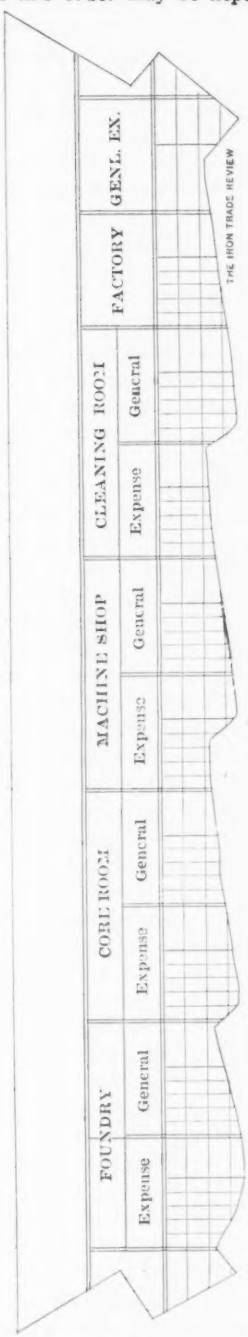
COST SHEET FOR MONTH OF January 1905 No.

DEPARTMENTS	SOURCE	COSTS	EXTENSION	AMOUNT	TOTAL
FOUNDRY					
Iron	Iron Rept. #1	833034			
Supplies	Stock Record	51680			
Sundries	Journal 86	7118			
Productive Labor	Pay Roll 116	193750			
Non-productive Labor	" " 116	33160			
Repairs	S. Order #a 278	4812			
Total Cost for Department		1123554	1123554		
CORE ROOM					
Material	Stock Record	9058			
Sundries	Journal 86	2600			
Productive Labor	Pay Roll 117	36210			
Non-productive Labor	" " 117	8450			
Repairs	S. Order #a 278	3960			
Total Cost for Department		60278	60278		
CLEANING ROOM					
Expense for Tools, etc.	S. Order #a 272	1460			
Labor	P. Roll 119	35920	37380		
Repairs					
Total Cost for Department		37380			
MACHINE SHOP					
Wrought Iron	Stock Record	4817			
Supplies	" "	2918			
Fuel and Light	Voucher Bk 94	7811			
Sundries	Journal 86	1219			
Productive Labor	Pay Roll 118	61250			
Non-productive Labor	" " 118	16260			
Repairs	S. Order a 278	1118			
Total Cost for Department		95393	95393		
Unclassified Labor			51410		
Factory Expense			21896		
General Expense			11416		
Net Cost of Production			1401327		1401327
Patterns and Flasks				29175	
Office Expense				26110	
Special Expense				5111	
Freight				41113	
Taxes, etc.				3260	104769
Total Cost of Operating					1505896

PRODUCTION	WEIGHT	AMOUNTS	LAST MON.
Weight Castings, Class A	12692	190 38	
" " " B	168498	2527 47	
" " " C	531501	8610 32	
" " " D	381916	6492 57	
" " " E	42111	842 22	
" " Shop	3101	20 34	
" " Special			
Total Weight Good Castings	1139819	18683 30	
Total Weight Bad Castings	48196		
Total Production			
Add Machine Work		342 22	
Add Special Jobs			
Total Value for Month		19025 52	
Deduct Cost		14013 27	
Profit or Loss		5012 25	
Net Cost		14013 27	
Per lb.		0122	
Whole Cost		15060 96	
Per lb.		0132	
Average Daily Casting Loss	112.8		
Per Cent " " "	.042		

Remarks:

card. In case of an order requiring a number of operations to complete, the cards of this order may be kept together



FORM 15.—SUNDRY EXPENSE AND MAINTENANCE.

in an envelope until the order is completed, when they may be taken out and entered up. As soon as all material and productive labor is entered on the card, a percentage is added for non-productive labor, which percentage may be easily obtained from the payroll, owing to the peculiar arrangement of the columns. A percentage may also be added for factory and general expense, which may be obtained from the cost sheet. These items are then footed up, giving the total cost of the order. In some lines of foundry work it may be desirable to keep the cost of each separate order that is gotten out, in which case arrangements will have to be made for keeping the molder's time on orders that a considerable period of time is required to complete.

Stock Records.

By stock records we refer to finished castings and not to material, records of which are classed under the head of stores. The stock record is, however, nearly identical with the material record, and is operated in practically the same manner. Usually the castings are shipped out as soon as possible after being made, so the stock record is not very difficult to run. The production sheet has a special column for the weight of each class of castings made, which weights are extended on all production sheets, and are transferred from there to the stock record. This is shown in Form 13. The record of each class of castings is kept on a separate page of this record, and runs for one month, when the balance will be transferred to another sheet. The "made" section of these records is compiled from the production sheet, and the "shipped" section from the invoice copies. The arrangement of the sheet is practically identical with the material record, so further description is unnecessary.

The Cost Sheet.

The cost sheet is shown in Form 14. This sheet is the ledger of the cost system, the other forms shown being the corresponding items to the sales books, cash books, etc., in an ordinary set of account books. The monthly iron report, the material record, the pay roll, the shop order cards, the production sheet, and special columns in the cash book, and voucher record, or purchase

book are all made use of in compiling this sheet. It shows the cost of each separate department, giving the cost of each of the principal expense items. The foundry department comes first, then iron, supplies, sundry expenses, productive and non-productive labor and repairs or maintenance. Cost of iron is obtained from the monthly iron report, supplies from the material record, productive and non-productive labor from their respective columns in the payroll book, and sundry expenses and maintenance from the special columns in the cash book and the voucher record or purchase book. These columns are arranged as shown in Form 15, the pages being ruled into spaces for each department, and subdivided into expense and general columns. In this way the actual cost and expenses of various kinds for each department are entered on the cost sheet just as they come from the books of original entry, and are thus a matter of facts and figures instead of guess work. Repairs are taken from the cards containing the record of shop orders, a shop order being issued each month for repairs in each department and all material and labor used for repairs are charged against these orders. This gives all the expense items of different kinds for the foundry for the month, and these are footed up and the total carried into the extension column. The same methods are pursued in getting the costs of the other departments. In addition to the department labor, a space is given to unclassified labor, and when this is added, all labor is accounted for, and will check exactly with the payroll. Factory expense and general expense are taken from the books of original entry, through the columns shown in Form 15, and when these items are footed up, the net cost of production is obtained. Patterns and flasks, freight, taxes, and other items not directly concerned in the cost of production are then added, and the sum of these items and the net cost of production will give the total cost of operating for the month.

There are many, no doubt, who will disagree with the method in use on this sheet of putting the patterns and flask item in the class shown, thinking, rather, that it should go into the net cost of production. There are excellent reasons, however, for classing it as shown. In the first place, patterns and flasks should show in the total cost of operat-

SUMMARY OF COST SHEETS FOR

Month	Weight	Cost	Per lb.	Value	Per lb.	Gain	Per lb.	Loss	Per lb
January									
February									
March									
December									

FORM 16.—RECAPITULATION OF COST AND VALUES.

ing, and should be charged against the order on which they are made, but in other respects they are the same as machinery, and the cost of new machinery is not charged against the cost of production for any particular month. Of course, the amount allowed for depreciation will be much higher than for machinery, but the principle is the same. In the opinion of the writer it is entirely wrong to charge up the cost of any pattern or patterns against the cost of production for any single month. These patterns may be expensive to make, and may be used on future orders for months or years to come, so it is manifestly unfair to charge up their cost against the month in which they were made. It is far better to treat the pattern shop as if it were a separate factory altogether, in no way connected with the actual production, and to charge it with material, labor and expense it incurs, crediting it with patterns and flasks it produces, doing this through the general ledgers, and not through the cost sheet. Figure this expense in the cost of operating for the month, but keep it out of the cost of production. In other words, treat patterns and flasks as machinery, and not as supplies.

If all the reports and records shown here have been correctly kept, the cost of production will be completely and accurately shown on the cost sheet. At the end of the year, the cost as shown by the sheet should and will exactly tally with the books of original entry. The percentage of general expense and factory expense can be derived from this sheet by dividing their amounts for the month by the footing of the "extension column."

The other section of the sheet is devoted to a recapitulation of the production for the month together with general information regarding the costs per pound, and percentages of the castings. This portion of the form may be varied to suit the requirements of the user or may be omitted altogether, but it is a useful and convenient record, and in most cases it is advisable to keep it.

Form 16 is a recapitulation of costs and values for a year or half year as desired. It is designed principally for the purpose of comparison from year to year, as well as a means of checking the cost sheets with the regular account books. It is simple in form and will not require much description. Columns are provided, showing the production, cost, value and loss or gain for each month. The loss or gain for the year will, if these records have been correctly kept, tally with that shown by the general ledgers.

The system described is devised, as stated above, more as a general guide for a foundry cost system than as a pattern to follow for any special line of foundry work, there being many portions of the entire system as well as of the separate forms which will not be at all suited to some lines of foundry work, no matter how adaptable they might be to others. But the principles we believe to be sound, these principles being to report all material and labor correctly and to obtain all other expense items from the general account books and not to guess at them, and to have the system at all times in shape to be checked with the general ledgers. This we believe to be the only practical way to operate a cost system, and the special methods shown here have all been proved sound by actual use, it is therefore offered without hesitation on the part of the writer for the use of those who wish to get up a practical cost system for their foundries.

The Niles-Bement-Pond Co., of New York, has issued a catalog 9 x 6½ inches, illustrating and describing out door cranes. These are especially suitable for foundry storage yards, flask yards and other similar locations. Such cranes are made with very long spans, one of those illustrated having a span of 91 feet.

The exhibit of foundry supplies and equipment in connection with the Foundrymen's convention next June in Cleveland is going to be the most complete of its kind ever held. You are sure to get some good points from those present.

OPEN-HEARTH STEEL CASTINGS,—V.

BY W. M. CARR.

Basic Practice.

The problem of charging into a basic open hearth furnace phosphoritic and otherwise impure materials, converting the same into good castings, offers many interesting features. To get satisfactory and uniform results, certain conditions require close attention and niceties of adjustment. When with a suitably lined basic hearth and the proper melting stock it is possible to begin with a high initial phosphorus and sulphur content and end with an almost complete removal of them, it is clear that the chemical history of the manipulations in conversion is more varied than that of an acid heat. As already stated 95 per cent of the phosphorus and 60 per cent to 75 per cent of the sulphur can be eliminated in a basic bottom; there is then offered an opportunity to produce a class of output with a very low composition. Concerning the other constituents the conditions in regard to their removal during conversion and their presence in finished product are practically the same as in acid castings.

Given, then, a basic bottom and melting stock, the changes in a heat will be considered. The function of the basic bottom is only a refractory one and the material entering into it plays no part in the direct purification and conversion of stock. The calcerous slag is the active agent and the bottom must be of such material that the action of such a slag will have the least possible cutting effect. To minimize that effect, the best results will be obtained with a magnesite lining prepared as previously described. Limestone or calcium carbonate forming the slag and classified as a "base" will not flux with magnesite also a "base." That is, an admixture of two or more bases will successfully resist high temperature or those common to steel melting; but a combination of an acid (silica, etc.) and a base (lime or magnesite, etc.) will at similar ranges of temperature readily fuse. Hence the metallurgical necessity of the hearth lining being of a similar character chemically to that of the slag which may be formed in open-hearth melting.

Silica being greedy for any base and always ready to fuse in the presence of a base, the life of a basic hearth will be subject to its influence, therefore it is important that the substance be allowed to enter the charge only in the smallest amounts possible. Through the charge it will be carried in as silicon (subsequently changed to silica) and sand adhering to the stock. With pig-iron cast in chills, the amount of sand from that source will be practically nil. Defective castings changed directly from the molding floor may have more or less sand on them and unless they are carefully cleaned to free them from burnt cores, etc. there will be danger of undue hearth scorification both on slag line and bottom, causing an increased use of refractories for patching.

Theoretically silica or silicon should be absent in basic stock. Practically it is not free from either, but the condition is none the less subject to control. Therefore in selecting pig-iron for basic melting the maximum percentage of silicon is given as 1 per cent. The amounts of that element in the various kinds of steel scrap are so low that the figures are negligible. Assuming the total charge to be equal parts of pig iron and steel scrap the initial silicon carried in by stock will average about 0.5 per cent. It is good practice to keep in the neighborhood of that figure, but a slight variation or increase will not be a serious objection. If there should be on hand some "off basic pig iron" that is high in silicon (over 1 per cent), or high in sulphur (over 0.05 per cent,) a small quantity can be charged at the rate of about 1 per cent of the charge and will have but a very slight effect upon the desired initial composition.

In regard to sulphur and its position in the composition of the charge, it does not seem necessary to be very rigid as to how much can be considered dangerous. Actually standard basic pig iron, while rated at 0.05 per cent maximum carries more than that because of the generally accepted method of analysis giving uniformly low results. Were a more tedious method and a more accu-

rate one employed, the figures on sulphur would generally be nearer 0.07 per cent than the standard stock requirements; hence the amount of sulphur actually going into a charge is really higher than shown by the individual analyses of the pig irons forming part of it. The same differences between the apparent analyses and actual content of sulphur holds true on various grades of pig iron until very low amounts are reached. In the light of recent practice, the influence of sulphur in finished product is not regarded as harmful as it once was. There is therefore no good reason to place a strict limit on how much shall go into a charge. On an average the total amount will rarely go above 0.04 per cent. Rail scrap frequently carries 0.07 per cent and over. The pig iron will range from 0.01 to 0.05 per cent, and with many kinds of steel scrap to select from, ranging from 0.02 per cent and higher, it will not be difficult to keep the initial sulphur at or about the average stated if so desired. In the writer's experience there was a time when it was considered bad practice to have the initial sulphur exceed 0.03 per cent, and the aim was to get lower. (At this point the question as to the influence of sulphur will not be considered, but will be deferred to a subsequent section). With a normal basic slag and proper conditions, much higher ranges of initial sulphur can be safely handled. There will be almost complete elimination in conversion, so that specification for finished product can be kept within easy reach even with an initial sulphur of 0.07 per cent.

Concerning phosphorus and keeping in thought the ulterior limit in the analysis of finished product, it is as well not to make the entire pig iron charge all high phosphorus material. While the figures on standard basic pig iron are 1 per cent and were drawn for ingot practice, for castings it is better to have at least two kinds of basic pig of which one may be low and one other standard. A brand carrying about 0.25 per cent of phosphorus or less is not difficult to procure. With a charge of mixed brands of pig iron, and the usual varieties of scrap, it will be possible to keep the initial phosphorus of the charge low. During the progress of conversion and with a strongly basic slag, there will be practically a total absorption of phosphorus by it from the bath. At the end of the heat in recarburizing with ferro-silicon, etc., there will be a tendency on the part of the phosphorus to re-enter the metal, depending in a great measure upon the amount of that element charged, and the basicity of the slag. There is always some re-absorption, and it is greater with all high phosphorus pig than when it may be diluted with low phosphorus pig iron. Hence the need of mixing the pig iron in regard to phosphorus content. Average practice will give a negligible reabsorption if the initial phosphorus is about 0.1 to 0.3 per cent.

In addition to the elements enumerated, there is always more or less manganese carried in with the stock. In basic melting it is useful in several ways. One function is to assist in maintaining a necessary fluidity of the slag, and it will exist in that body principally as an oxide, resulting from the metal in the charge. It also aids in the removal of sulphur in the bath, and at some period during the melting unites with it, forming a readily fusible sulphide of manganese which floats upwards, and either dissolves in the slag or upon reaching the surface and becoming exposed to the flame action, may be oxidized or volatilized. The action of manganese, however, is not quite clear, but from actual results there is no doubt that its influence in de-sulphurizing is quite potent. In that respect its operates in conjunction with the Ca O (lime) furnished by the limestone, which is also an active de-sulphurizer. It has been observed that a moderately high initial manganese assists in washing the bath of dissolved oxides always present in metal which has been subject to the impinging action of the flame before the period of liquation has been reached and the mass disappears below the slag. The deoxidizing effect will not begin until the mass has partially or entirely fused and is covered with a layer of slag. Deoxidizing will take place by the union of silicon and carbon with the oxygen and whatever manganese may be present in excess of

that which may unite with the sulphur will considerably augment the effect. The joint operation of the three elements will certainly give cleaner metal. With ordinary melting stock the average or initial manganese will be about 0.5 per cent, but if it is possible by the use of a high manganese pig iron to raise that nearer 1 per cent, the results or deoxidizing effect will be more satisfactory. Or in the absence of that kind of melting, stock, the deficiency can be made up with spiegeleisen, an alloy carrying 20 per cent of manganese, or a certain amount of manganese ore will be useful for the same purpose, if charged at the proper time,—before the first portion of metal. It is recommended, however, that the needed manganese be carried in by high manganese pig iron, because it is possible to get a better distribution of that element than by adding a small quantity of the alloy mentioned to make up any deficiency. For that reason it is good practice when purchasing melting stock, to have on hand pig iron carrying between 1.5 to 2.5 per cent manganese.

Since pig iron generally contains 2.5 to 3.5 per cent total carbon and with 50 per cent pig and 50 per cent steel scrap the initial carbon of a charge will be from 1.5 to 2 per cent. Whether the carbon may be in the combined or ghaphitic form is not considered, because when the pig iron is liquid, it is all in the former condition irrespective of the constitution before melting. It will be observed that there is a difference between acid and basic melting in regard to the percentage of pig iron in the charge. In the former there will be 15 per cent, but in the latter 50 per cent. The reason for the difference is due to the larger volume of slag formed in basic melting, which requires a considerable portion of the heat units to penetrate it, to promote the necessary fluidity of the bath of metal below. As has been pointed out, the amount of carbon present largely controls the melting point of iron and steel and with a high initial percentage of it in a charge of cold stock, it is possible to acquire liquation at a relatively low temperature. Were there a low initial carbon as in acid melting, there would be much trouble with viscosity of the bath, because of heat absorption in the heavy body of basic slag. With the bath melted at a high range of carbon, the necessary thermal conditions are comparatively easy to attain. A high carbon at melting, between 0.5 to 0.8 per cent, is considered good practice; further, it means a prolongation of that period in which deoxidization or clearifying of the bath occurs. Whereas a lower carbon at melting would shorten that period, and at the same time there would be undesirable conditions likely to arise, such as low temperature of bath, and overoxidized metal, both tending to give bad results in product. Should a heat melt soft (low carbon) it can be "doctored" by adding cold pig iron, and the temperature raised by flame adjustments, but recourse to such treatment is always dubious as to the outcome.

The foregoing elements of the charge being adjusted in accordance with general practice, the next step will be to consider the slag composition, which is to play an important role in the conversion and purification of the bath. In contrast to acid melting, the slag will be one highly charged with lime, a substance already shown to be objectionable in an acid hearth, but desirable in treating basic stock. The normal composition of a basic slag will not be reached until the stock has melted and the slag attained its maximum fluidity, which period occurs during the second stage of a heat that for convenience may be designated "Metals Melted." Taking as an average the analyses of twenty samples of slag selected from various normal heats in the second stage, the following can be considered the usual composition of a basic open-hearth slag.

Silica	16.00 per cent.
Ferrous oxide	22.00 per cent.
Lime	40.00 per cent.
Magnesia	8.50 per cent.
Manganous oxide	8.50 per cent.

The foregoing analyses can only be regarded as applying to the conditions of practice, existing when they were made and not as a rule to follow in all cases, but under general conditions they may serve as a guide. In order to form a basic slag there are several important conditions to take into account. First, enough Lime must be added to combine

with or neutralize the Silica, which will result from the oxidization of the Silicon carried in by the metals, and that carried in mechanically as sand; otherwise, there would be a thin slag and an undue cutting of the hearth by the Silica. Second, too much Lime must be avoided which would tend to form a thick, pasty slag that would cause trouble in tapping the furnace or bring about a heavy consumption of Fluor-Spar to flux it.

There is a medium to be sought between Basicity and Fluidity and at the same time the function of the slag in absorbing and retaining phosphorous must not be overlooked. The measure of the latter action mainly depends upon the amount of lime in excess of that united with the silica, lime in a basic slag being the active de-phosphorizing agent. As to fluidity, that condition in addition to the influence of silica will depend upon the varying amounts of Manganese in the stock which enters the slag as an oxide. Oxide of iron operates in the same manner and is always present independently of that added as iron ore. The iron oxide of the slag will result from the rusty coating on the stock and the impinging action of the flame during the first stages of a heat. In general terms the higher the content of silica the greater the fluidity, but at the expense of de-phosphorization and hearth. Fortunately the medium can be found because of the presence of iron and manganous oxide, since a law seems to exist in slag formations that fluidity or fusibility is controlled by the *number* of bases present. So assisted by manganous oxide and iron oxide in the presence of lime and silica desirable slag conditions in basic melting can be attained without much difficulty. In addition to the elements given in the slag analyses there may be small negligible quantities of Alumina and Alkalies. The amount of Magnesia results mainly from hearth cutting. To forecast the exact amount of Lime to be added solely on theoretical grounds is not easy, because the total available silica cannot be accurately determined owing to the uncertain quantity of sand adhering to the stock. Whatever silica may be available in the stock will require at least enough lime in the ratio of 1 to 3 to satisfy it. Also the purity of the limestone, generally used as a carrier for the necessary lime of the slag, must be taken into account and any silica this may have will depreciate the available lime in the same degree. Therefore, the nearer a limestone approaches a pure carbonate of lime the greater the efficiency. In actual practice the amount of limestone required to form a normal slag will vary between 7 and 15 per cent of the weight of the charge. With standard melting stock and a pure limestone it will be comparatively easy to get satisfactory adjustments. In the hands of a skillful operator assisted by the chemist the behavior of a heat can be followed at any desired stage, so that untoward conditions of purification will be within control. Agencies are constantly at work in slag formations following the laws of attractions and affinities which present problems of scientific interest. To solve their complexities would be a difficult task.

If an open-hearth furnace be regarded as a chemist's labratory experiment on a large scale, and viewed from a chemist's standpoint, the delicacies of definite chemical reactions are not obliterated because of the very hugeness of a furnace. Whether the operation be conducted on a minute scale or on a larger one, definite laws are omnipresent. Could the operator bear in mind that he is handling tons of material with forces equally potent as in the chemist's ounces, he would stand in awe of them. Careful, intelligent work combined with practical experience makes it possible to put basic practice in the same plane of efficiency as acid melting notwithstanding prejudice to the contrary existing in some minds.

Having determined upon the amount of limestone to form the basic slag, the next step will be to consider the order of charging. With a basic hearth prepared as outlined in previous sections the method of charging may be conducted as follows: First the stone is spread over the bottom in as regular layers as possible followed by the lighter sections of scrap, which should be more or less rusted, or if not rusty, some iron ore

may be added with it to make up the lack of oxide to assist in subsequent slag fusibility. Then two-thirds of the pig iron distributed as evenly as possible, which may be followed by the remainder of the scrap. By this time the furnace will be well filled with bulky stock, and it may be necessary to allow the flame to partly melt it, thus, forming room for the final addition of pig iron. The serious part of melting now begins and at this stage the finished product in regard to quality will be greatly influenced by the manner in which the exposed stock may be subjected to flame action. There will be a desire on the part of the operator to get the heat out of the furnace in record time and with speed in mind the temptation to use a sharp, hot flame will be strong. On the other hand, a soft, mellow flame will not melt as quickly as a sharp one, yet the character of the product will be better than under the first named conditions. In one instance the bath will be highly charged when melted with dissolved oxides and in the other instance less so. It is not possible under any conditions to melt a mass of pig iron and steel scrap without some formation of oxides, and their subsequent solution in the bath, so long as it remains uncovered by a protective layer of slag. Good practice requires that there be a dividing line between speed and slowness, a sharp flame and a soft one, and that object is a difficult one to reach. The quantitative expression of dissolved oxides cannot be stated, but their influence can be detected in varying degrees. That such conditions do exist is a fact, and the conclusion is based upon careful observations and research, the results pointing undoubtedly to the influence of the flame action whether gas or liquid fuel may be used and also the amount of initial carbon present in the stock. Oreing during the second stage or "Metals Melted" also may aggravate the evil. That it is an evil, will be pointed out, and, one not fully appreciated or understood. To it can be traced the non-success and consequent prejudice against basic melting, because, in some instances, it has been found in certain physical requirements that basic steel was not as good as acid steel for castings. In other words, expressing the difference between basic and acid steel in regard to certain physical properties, basic steel is more likely to carry dissolved oxides than acid, provided care has been taken to guard against their introduction or formation. Differences in chemical composition can only exist in the amount of sulphur and phosphorous for a given grade of product and the said differences being too small to exert any great influence, no cause can be assigned other than the one mentioned in studying the contrasting physical properties of both classes of steel. The condition of over-oxidization is not so liable to present itself with a gas flame, but even such a flame can be so adjusted as to abuse the stock. With an oil flame the danger is greater, because of the intense blow pipe effect of the oil burner. In experienced hands, however, quality duly regarded, normally, the oxidizing effect with any kind of fuel need not be excessive.

Under flame action in a fully charged furnace the stock will soon begin to melt and it will be observed that the melting of the pig iron goes on quite rapidly, dripping to the hearth in small streams, while the steel scrap melts at a slower rate, and in melting, the liquid steel frequently scintillates or burns forming either vapors or solid oxide. The dripping pig iron lessens that action, more or less, by protecting the lower carbon steel stock. The melting proceeds gradually, and the mass decreases in bulk and passes below a layer of rapidly forming slag. At this time, however, the slag formation is not entirely complete, but will be found to consist mostly of silica and iron oxide with comparatively little lime. The temperature of the furnace at this point not being sufficiently high to thoroughly dissolve the lime still resting on the bottom of the furnace. The composition of the slag at this period is practically an acid one and results from the sand of the stock and the silicon of the metals, since it is one of the first elements to submit to oxidization. Samples taken from the first portions of melted metal have shown a high sulphur content,

much higher than that carried in by the stock. The cause can be attributed to the absorption of sulphur from the flame. During the first stage but little information can be ascertained as to the changes which may take place in the composition, because the mass is a conglomeration of pasty semi-liquid pig iron, steel and slag.

METHOD FOR DETERMINATION OF PHOSPHORUS AND ASH IN COKE.

BY JOHN F. HOY.

As every chemist knows, who has coke analyses to make, the methods in use at the present time for the determinations of phosphorus and ash are very long and tedious, and a method which would considerably shorten these determinations would be welcomed.

The method here given first originated in the Laboratory of the New Jersey Zinc Company, Hazard, Pennsylvania, and has never to my knowledge been in print.

Ash.

Brush one gram of finely powdered coke into large weighed platinum dish of about 150 cc. capacity; add enough absolute alcohol to sample to make a thin paste. Now revolve the dish slowly so as to cause the thin paste to run up along the walls of the dish. Keep up this motion until all the alcohol is evaporated and there remains only a thin film of sample over the walls and bottom of dish. Now place the dish over blast lamp, or in muffle furnace, and in five to seven minutes the carbon will have been entirely burned off, the ash remaining. Weigh and calculate percentage of ash.

Phosphorus.

Five to ten grams of sample should be taken. Proceed as in ash determination. When the carbon has all been burned off,* add to the ash in dish 10 cc. dilute HCL and 29 cc. HFL. Evaporate to dryness under a good hood but do not bake. When cool add 15 cc. HCL and heat. The residue should all dissolve, but a little insoluble matter may be filtered off and neglected. Pour the solution into a flask, add NH_4OH, then HNO_3, and then molybdic acid solution, and "shake down" phosphorus. The yellow precipitate may be either weighed direct or titrated.

* See J. M. Camp, page 139, "Methods around Pittsburg."

The Foundry Foremen's sessions of the convention promise to be unusually good, and a large number of very helpful papers will be presented.

TRADE PUBLICATIONS.

The Harbison-Walker Refactories Co., Pittsburg, Pa., is sending out a catalog 3¼ x 6 inches entitled, "A Little Talk on Brick for Boiler Settings." The book is, however, broader than its title, and gives much valuable matter and many illustrations which are of interest to the foundrymen or any one requiring refractory material.

The Goldschmidt Thermit Co., of 43-49 Exchange Place, New York City, have issued a pamphlet 5¼ x 8¾ inches, giving instructions for the butt-welding of wrought iron and steel pipes by the use of thermit. This process has been very much simplified by the introduction of specially made cast iron molds for use both upon vertical and horizontal pipes.

The Buck's Stove & Range Co., of St. Louis, Mo., has just issued a large catalog 7½ x 10½ inches, describing the product of their factory, also showing the general view of the factory and giving a word to those who sell stoves. The most unique feature of the catalog, however, is found in an insert printed on buff paper describing the Buck's advertising plan, which is a system in accordance with which the company assists the merchants purchasing its product in the disposition of the same. In other words, it is an expert advertising bureau maintained for the benefit of the patterns of the Buck's Stove & Range Co.

BRASS FOUNDING

THIS DEPARTMENT IS DEVOTED TO THE TREATMENT OF ALL ALLOYS INCLUDING THEIR

FOUNDING, GRINDING, POLISHING, ELECTROPLATING ETC.

SOME OLD BRONZE CASTINGS.

We are wont to think our own work is the important work and to look upon the various trades as of comparatively modern origin. To this age belongs the rapid duplication methods which enable us to produce large quantities of work at a very small cost, and thus bring within the reach of the masses all of the necessities and many of the luxuries of life. These luxuries and many of the necessities of today have been enjoyed by the wealthy for centuries.

Works of art, or tools and devices used in past ages, which have been handed down to us from antiquity, are in many cases of doubtful origin, and it is exceedingly difficult to tell their exact age.

The catastrophe which overthrew Pompeii and Herculaneum in A. D. 80, has preserved for us much valuable information concerning the life of that period, and from these excavations art treasures have been recovered which give us a very close insight into the life of that time.

The accompanying illustrations show some photographs, most of which were taken in the museum at Naples, and were placed in our hands through the courtesy of John Fry, editor of the *Iron Molder's Journal*. A description of some of these pieces was published in the *Journal* of February, 1906.

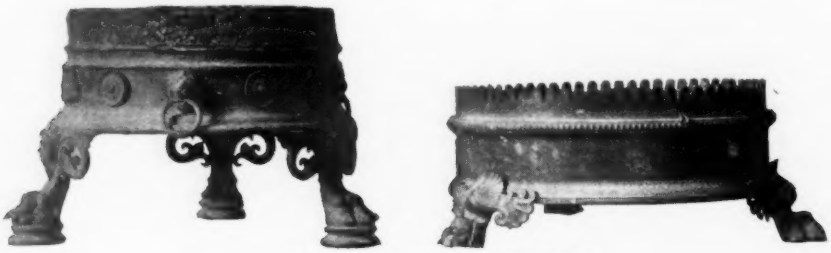


FIG. 1.—TWO CIRCULAR BRAZIERS.

The brazier or fire pot is probably the oldest metal device constructed for furnishing either heat or light. The accompanying illustrations show several braziers which were used for heating purposes only.

FIG. 2.—A PAIR OF RECTANGULAR BRAZIERS.

The two illustrated in Fig. 1 are small circular braziers which rest on three cast feet. In fact a large number of the pieces found are provided with three feet, and this leads us to believe that the artisans of these early days were acquainted with the principle which was expressed by an old farmer a few years ago by saying: "I have

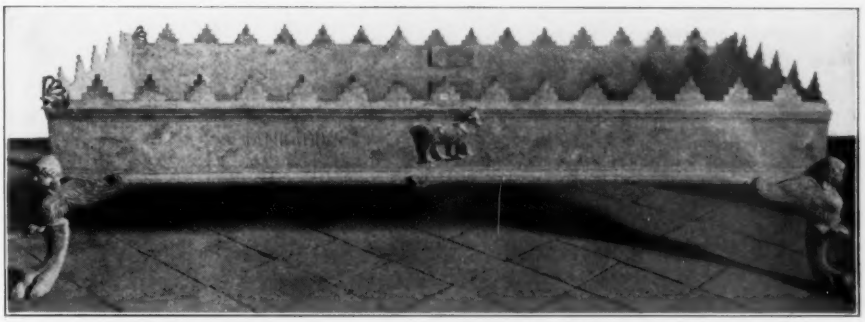


FIG. 3.—A LARGE BRAZIER FOUND IN THE PUBLIC BATHS.

observed that a three-legged milk stool never rocks," in other words, three legs will come to a bearing on any surface. The braziers illustrated in this view are fine examples of the founder's art and metal finisher's skill. The one on the right shows particularly good workmanship.

Fig. 3 shows a large brazier which was found in the public baths. This brazier was probably heaped with charcoal and used as a source of heat in cool weather.

Fig. 4 shows a combined brazier and water heater. The brazier pan proper is surrounded by a passage containing

FIG. 4.—LARGE BRAZIER SURROUNDED BY WATER JACKET.

In Fig. 2 are illustrated two rectangular braziers both of which show a large amount of work. The feet of the larger brazier in particular, exhibit a fairly intricate piece of molding with some core or drawback work necessary. The plate or sheet metal work was evidently in some cases cast and then the parts riveted together, and in other cases the sheet metal was beaten out from the ingot.

water. The water is introduced through loose lids in the tops of the four towers, and is drawn through one side by the spigot plainly shown on the right. For moving the brazier from place to place four handles are provided as shown. This is evidently one step toward the production of our modern hot water back and hot water heater for the cook stove. This principle, however, is better illustrated in the

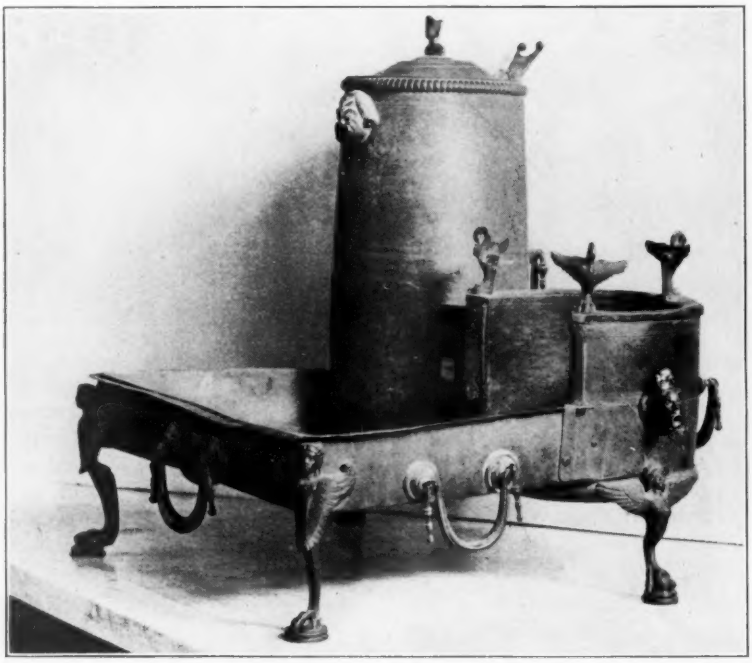


FIG. 5.—A BRAZIER WITH HOT WATER BACK.

brazier shown in Fig. 5 and in cross section in Fig. 6. In this case the brazier pan is supported on four legs with claw feet and winged sphinxes where the legs connect with the body of the brazier. There are five handles for moving the brazier. Water is introduced into the large urn at the back, from which it passes around through the bronze water back to the cock shown on the front. This spigot is of ornamental design, being made in the form of a mask, and the handle being arranged like a plume. Provision is also made for the escape of steam through an opening in the mask, shown at the left of the urn. These braziers were probably also used for warming food, and surmounting the water back are three winged supports between the backs of which a plate of metal could be placed for warming food. A supply of charcoal was probably kept in the main part of the brazier pan, and the fire or hot coals piled inside of the water back.

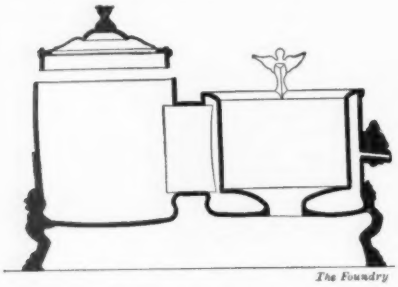


FIG. 6.—SECTION OF WATER BACK.

Several other forms of hot water heaters are shown in Fig. 7 and a cross section of the one shown at the left of Fig. 7 is given in Fig. 8 together with some details of the ornamentation. The metal work on this particular brazier is exceedingly fine. The upper part in particular showing fine chased work.

Another style of hot water heater made in the shape of an urn is shown in Fig. 9 and still another in Fig. 10. The two last mentioned pieces show a high degree of metal finishing in various parts, principally upon some of the bands around the base and top and in the leaf work or the wings for the sphinxes at the bases.

It is also interesting to note the accurately-formed hinges used in con-

FIG. 7.—SOME FIREPOTS AND WATER HEATERS.

nection with the doors and lids.

Lanterns were also used by the Pompeians even though common tradition credits the invention of this useful device to Alfred the Great. It is certain, however, that the lantern must have been invented at least three or four hundred years before Christ. One form of ancient Pompeian lantern is shown in two views in Fig. 11. This consists

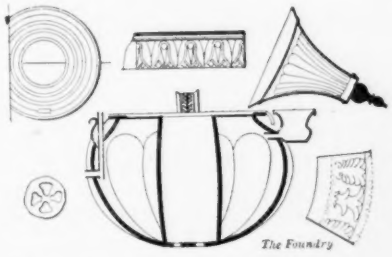


FIG. 8.—SECTION OF WATER HEATER SHOWN AT THE LEFT OF FIG. 7.—

of a metal frame surrounding a lamp which was probably protected from the wind by oiled paper or other translucent material.

We cannot help but wonder what kind of a shop or foundry these ancient Pompeian metal workers had, but so far as we know their work shop has not as yet been uncovered. Cast utensils are not the only ones found, for many of the vessels used were of beaten bronze or copper.

Fig. 12 shows the cooking place in one of the Pompeian houses, together with a number of the pots used in cook-

FIG. 9.—HOT WATER URN.

ing. The iron supports for the pots and the gridiron next the wall are both badly corroded, but the copper and bronze vessels are in a remarkably good state of preservation.

Those interested in the hot air heating furnace business will be interested

FIG. 10.—A WATER HEATER.

to know that hot air furnaces were used in old Pompeii. They were not, however, constructed on strictly modern lines, that is, of cast iron or sheet iron, but were made largely of tile and stone. The fire place was in the basement and tile flues lead back and forth under the floors of the living rooms and finally up through a suitable chimney. We can imagine that a furnace of this kind must have smoked fearfully when a fire was started for the first time, but after the flues and chimney were warm it would form a very efficient means of keeping the apartments at an equitable temperature.

As far as we know, at the time these implements and vessels were made some knowledge existed as to the properties of alloys. The first alloys made were obtained by smelting together ores containing the desired metals, but we know that soon after the beginning of the Christian era metallic tin was imported into Europe from Great Brit-

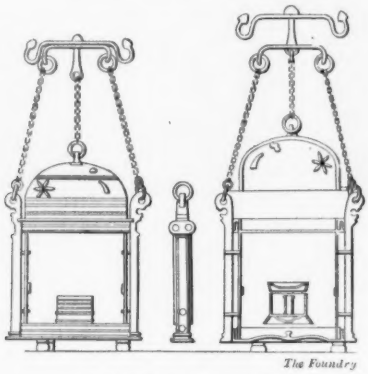


FIG. 11.—A LANTERN.

ain for use in alloys, and it is probable that the metal workers of Pompeii knew how to obtain alloys having different properties by blending different metals.

MARINE BRASSES.

BY JOHN H. BUCHANAN.

Inquiry.—An inquiry has been received asking for "formulas for (a) bearings for propeller wheels for ocean steamers, also for (b) propeller wheels, and (c) for other castings used about ships."

Answer.—This is a big order; it embraces all there is to the ship builders' brass foundry mixture book.

No information is given as to the class of ocean steamers and there is a big choice between the common tramp and the naval cruiser. A rough classification of ocean steamers would divide them into three groups, viz.: Admiralty ships, mail steamers and cargo boats. As to the first everything put into them is of the best and the alloys used by the various naval departments may be gleaned from books on stand-

FIG. 12.—COOKING PLACE IN A POMPEIIAN HOUSE.

ard metals, as, Thurston's "Materials of Engineering." Obviously the information sought for relates to steamers carrying passengers and cargo—merchantmen.

Taking the question in order: (a) is so obscure as to leave me in doubt which of three things may be meant. To explain, a ship's propeller is generally keyed on to a shaft which passes through the stern tube and hangs over the aperture between the stern and the rudder. In some cases an outer bearing is provided on the rudder brace.

Gun metal liners are either shrunk or cast on to this tail-shaft, which revolves in the tunnel bearings and projects through the ship into the sea. Now to make sure that the question is answered I shall have to give mixtures for shaft liners, tunnel and aperture bearings and the stern bushes as in Table I.

TABLE I.

	Copper	Tin	Zinc	Lead	Yellow Brass	
Liners	74	12	—	—	14	To shrink on shaft.
"	60	6	—	3	30	To be cast on shaft.
Bearings	81	10	—	8	—	For aperture.
"	80	6	8	6	—	For tunnel.
Glands & Bushes	66	6	—	4	24	For stern tube.

Lead figures in these mixtures because it helps to counteract the corrosive action induced by brass and iron in contact in a moist atmosphere or under water.

As a rule the stern tube is lined with *lignum vitae* stripes, or babbitt lining and the tunnel bearings are generally cast steel, babbitt lined. A cheap bab-

bitt is best for these parts as they are continually under water. A good mix. is lead, 80 parts; antimony, 16 parts; tin, 4 parts; but a better quality suitable for almost any part of a ship's machinery is composed of lead, 44 parts; antimony, 12 parts; tin, 44 parts.

TABLE II.

Copper	Tin	Zinc	Lead	Yellow Brass	
83	10	7	—	—	Piston rings, springs, etc.
64	4	—	1	8	Steam Metal.
8	6	—	2	44	Bushes, etc.
100	12½	—	12½	—	Bearings.
71	7	—	4	18	Valves, cocks, etc.
14	1	1	—	—	Bolts, studs.
84	11	—	—	4	Hydraulic connections.
84	10	4	2	—	Pinions and slides.
88	10	1	1	—	Pumps and plungers.

Coming now to the second part of the inquiry, (b), clearly means alloys for propeller wheels. Manganese bronze is undoubtedly the finest metal for ship's propellers. It is eminently suited for propeller wheels with portable blades, and the modern practice is to have the boss made of cast steel and the blades of some high tension alloy like aluminum brass, delta metal or manganese bronze (so-called). For solid propellers, that is, where the boss and blades are one casting, the best alloy, from a foundry standpoint, is the ordnance gun metal, copper, 90 parts; tin, 10 parts. This alloy is neutral to the iron or steel of the hull and corrosion is therefore slight.

In making the high-tension alloys aforementioned, which are all in reality copper-zinc alloys with aluminum, iron or manganese additions, up to about 2 per cent, it is best to fix a standard, say 60 and 40, copper and zinc respectively, and add the strengthening elements in some intermediary form as, aluminized-zinc, ferro-zinc or cupro-manganese. The shrinkage of these alloys is great and with castings showing heavy sections feeding heads are advisable.

Lastly, I am asked to give, (c), "formulas for other castings used about ships." We shall begin on the bridge and work gradually down to the lower regions. On the bridge we have the telegraph gear, the bell and the binnacle. The inside parts of the telegraph are of most importance; the cams and pinions require a strong gun metal of good wearing quality, copper, 88 parts; tin, 9 parts; zinc, 3 parts, or copper, 88; tin, 6, zinc 6. An excellent composition for telegraph and ship's bells is composed of copper, 81 parts; tin, 17 parts; zinc, 2 parts. On deck the fittings are mostly yellow brass. Copper, 63 and zinc, 37 with lead up to 3 per cent.

TABLE III.

Lead	Zinc	Tin	Antimony	Copper	
80	—	12	8.	—	Metallic packing
17	—	76	3.	3	Babbitt linings.
4.5	75	18	2.5	—	Antifriction castings.
—	76	18	—	6	Bearings.
12	—	80	—	8	Plastic metal for pasting.
38	—	42	17	3	Metallic packing for shavings.

Rails, stanchions and portlights should be of good naval brass, copper, 62; zinc, 37 and tin, 1 per cent. In the saloon and cabins german silver is economical and effective for brackets, lamps, etc. A good composition which withstands the action of sea air well is made up of copper, 56 parts; zinc, 24 parts; nickel, 18 parts; lead, 2 parts. A cheaper quality, copper, 54 parts; zinc, 30 parts; nickel, 16 parts. A substitute alloy is, copper, 3 parts; zinc,

12 parts; aluminum, 84 parts; phosphor tin, 1 part.

In the engine room all sorts of alloys are required for pumps, condensers, dynamos, and auxiliary engines. Only a few special mixtures can be given in the space here allotted. These are shown in Table II.

Plastic metal and anti-friction metal for linings should also find a place with the engine room stores. Some useful mixtures are given in Table III.

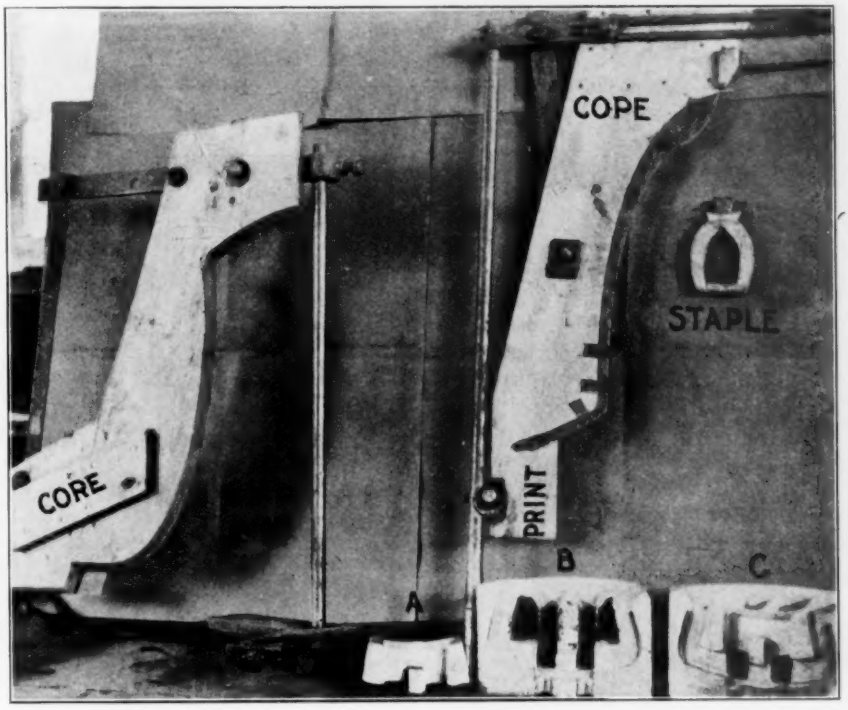


FIG. I.—RIGGING AND CORES.

CASTING A CHURCH BELL.

BY JOHN F. BUCHANAN.

The making of a presentation church bell, with raised beads, inscription and crown hanger, is, what the average molder would term, a nice, tasty job. Bellfounding is a specialty of the brassfounding trade, not because the molds or the metals are made differently, but because special skill is required to determine the exact shape and proportions for any given tone or note. Music, like mathematics, is an exact science, and musical bells must be made with due regard to the ratios of height diameter, thickness and volume. The bell which I have to describe was a 36-inch Cathedral bell, sounding A and weighing 931 lbs. Being a church bell it had been properly christened; the name was "Maud," cast in the year 1870 by the celebrated bell founders, Mears, London.

After 36 years' faithful service, "Maud" ceased to intone the first letter of the alphabet with her wonted solemnity. She became hysterical, gave forth spluttering sounds and finally, after three attempts to cure her lingual laxity, was pronounced "hopelessly cracked and fit for the furnace." Thus it was, I received an order with the original "Maud"—"Recast one church bell." As the new bell had to be the same as the original, the patternmaker took templates of the inside and outside in order to get the exact shape and thicknesses. A full-sized drawing was then made and sweeps for core and cope as shown (rigged) in Fig. I, were sent into the foundry. The crown hanger *d*, Fig. IV.

FIG. 2.—CORE.

was formed by two half core boxes; the separate cores are seen at Fig. I A, B; the letter C shows a complete half of the crown piece ready to slip into the print formed by the bottom part of cope sweep. The core for the body of the bell was swept up on a four-foot square drag (Fig. II), while the cope was made up of a deep cheek, a mid, and a top part securely bound together by ⅝-inch wrought iron tie rods. After the cope was built up to within three inches of the face, a cast iron grid was bedded in and bolted to keep the mold intact when it was turned over. Fig. III shows the finished cope in the beam ready to be turned and lowered over the core for casting. The wrought iron staple (Fig. I), is bedded into the crown of the core (Fig. II), at right angles to the double arms of the crown hanger Fig. IV. The hammer or striker for the bell is shackled to this staple, so it is important that it should be placed in the strongest part of the crown piece. The method of gating this bell is unique. Looking at the bottom of

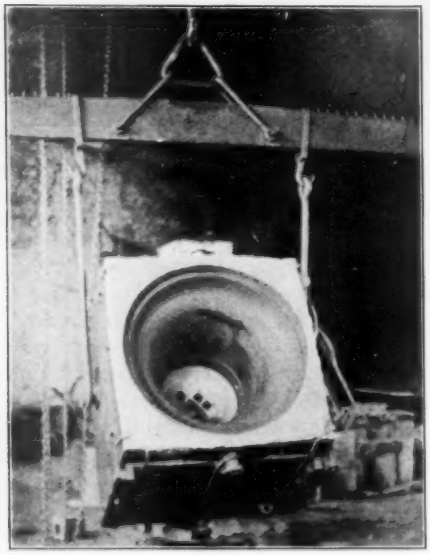


FIG. 3.—TURNING COPE.

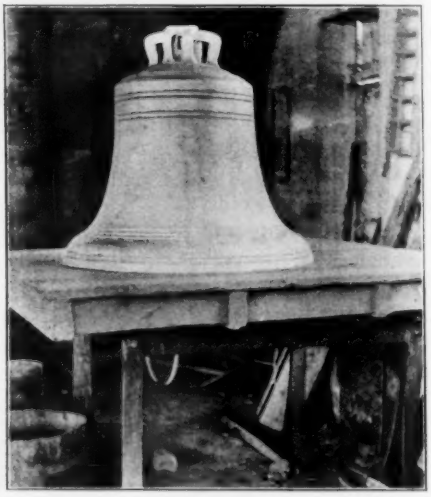


FIG. 4.—MAUD II. WEIGHT 937 POUNDS.

the half cores B and C Fig. I, you see two half round gutters connecting to the topmost rib of crown; these, when the two cores are joined, form the gates,—one inch and a quarter diameter, and by inserting two tapered pins the head basin may be rammed up before the cope is closed on for the last time. This ensures a clean casting, provided the head is kept full when pouring. The correct method of pouring large bells is to make a basin big enough to hold all the metal required for the casting and have the gates closed with a plug, to be withdrawn when the basin is filled. Risers are of no use here, because the metal is re-

quired to be as dense as possible and every added outlet is an attraction for the fusible compounds (tin-copper) to liquate while the alloy is cooling out. The fact that there was only six pounds difference in the weight of this bell and the original "Maud" shows close working, which was very creditable for a jobbing foundry. Bell founders get up special rigs for these castings, perforated cast iron casings conforming to the contour of the bell, with fixed seatings for the spindles, lugs for binding and trunions for handling,—which economize loam and labor and give accurate molds free from veins and cracks. The thicknesses in this bell varied from ¾ inch at the crown to 2¼ inches at the thickest part of the lip. The alloy consisted of the standard bell metal, copper, 80 parts; tin, 20 parts. Some designs permit of the cope being made by sweeping a thickness on the core, but a glance at Fig. IV will show that the smallest diameter is at the waist, hence, the undercut of the upper half would prevent parting it by this method.

BRASS FOUNDRY NOTES

BY C. VICKERS

REDUCING BRASS SKIMMINGS.

Inquiry.—I should like to know the best method of reducing brass skimmings. I have understood that they should be mixed in crucibles with alternate layers of charcoal, but have forgotten the details and should like to know just the way of reducing the metals from these skimmings.

Answer.—The question naturally arises: Are these skimmings "clean" or not? If they are, the easiest and cheapest way to reduce them is to put a little in each pot of metal. It is convenient to have a receptacle near to the furnaces, into which skimmings, sweepings, and spillings, may be thrown as they accumulate, they are then used up without any trouble, the slag that forms when skimmings are melted forms a good cover for melting brass, and prevents oxidation. Skimmings may be also reduced alone with or without charcoal. When this is done it is usual to save the old crucibles for melting them in. A pot that is too thin to risk a regular heat, will often give good service in melting skimmings. The pot is charged and the fire urged, to its greatest heat. We have then a small quantity of brass and a lot of slag in the bottom of the crucible, charge more skimmings on top of the slag, and when these skimmings get heated, push them down into the melted metal. This cools things off somewhat, and allows of the removal of some of the slag, which may be dipped out, and more skimmings charged. The process being repeated until the crucible is considered sufficiently filled with metal.

When old crucibles are used, it is not wise to try and melt down too much at one heat, as the pot is liable to get soft, and spring a leak. Therefore, charge the skimmings a couple of times and when melted, knead the mass of slag thoroughly with a poker to liberate the imprisoned metal, then draw the pot from the fire and skim. Do not allow the skimmed slag to mix with skimmings of regular pots which may be laying on the hearth; keep the slag to itself, and when cold, break with a hammer, to get out any particles of brass, then throw the slag away, then it will not become a part of future skimmings and the process be repeated "ad nauseum." The reduced metal may be run into ingots, but it is an economy to pour it directly into castings, thereby avoiding unnecessary remelting.

Skimmings should never be allowed to accumulate; some founders store them away in barrels, intending to tackle them at some future date. This is not, in my opinion, good management, as skimmings are very rich in metal and their storage means dead capital.

The skimming hearths should be cleaned up every morning at the least, a good plan being to sift them through a No. 16 seive; this removes the dust, the cinders, bits of slag and large pieces of brass being picked out by hand. The residue is placed in the tumbling barrel, with the castings, which they help to clean, at the same time being themselves

cleaned. Modern tumbling barrels are constructed with a view of cleaning skimmings and separating the brass, and dirt. The old style water tumbling barrel merely saves the larger pieces of brass, the fine particles and the sand find their way into the tank or box in which the barrel revolves. When this gets full of silt, it must be emptied, and the dirt washed to recover the brass. For this purpose a No. 40 brass screen seive should be used. A shovel of silt is placed in the seive, which is then agitated in water in such a manner that the sand, cinders, wood, etc., is washed away, the metal remaining in the seive; this is then cleaned of iron and is ready for reduction in the manner above suggested.

A FOOT POWER SPRUE CUTTER WANTED.

We have received a letter from J. B. Chapman & Co., brass founders, coppersmiths and machinists of Springfield, Mass., in which they state that they have been trying to secure a sprue cutter suitable for their work, but so far have been unsuccessful, and that they find that there are a number of other foundries situated as they are, that is, the conditions are such that there is no power in the room, and hence a good substantial foot power sprue cutter which was made strong enough to withstand the muscle of the ordinary able bodied foundry laborer is what is desired. The machine should not only be strongly built and its working parts amply strong, but the cutter should be stronger than this furnished on many of the machines. On foot power machines the cutters frequently bend or break. The writer states that it is his opinion that if a machine were built to meet these requirements, it would meet with a ready sale.

AN ENDLESS POLISHING BELT.

L. H. Gilmer & Co., of Philadelphia, are manufacturing an endless polishing belt, which is a woven fabric belt, so spliced together as to form an endless belt, or single piece of webbing. The splice is of the same width and thickness as the rest of the belt and is just as durable as any other part.

After being stretched, the belt is treated with a special preparation which sets it and acts as a base for the glue and emery. After this, the belt will not stretch or change in length to any appreciable extent.

A GOOD MANUFACTURING OPPORTUNITY.

Tradition and the past condition of the trade has a large amount to do with the location in which articles are manufactured, or metallurgical processes carried on. For a great many years, in fact for several generations, the Swansea district in England was the most famous copper refining district in the world, and naturally a great many allied metal industries thrived in that vicinity. Considerably over one hundred years ago, a number of brass workers came to this country and settled in the Naugaut valley in Connecticut. These men naturally followed their old business, and from the small beginning which they made has grown up the largest brass and copper industry in this country, including the manufacture of brass wire, plate and sheet metal and a large variety of spun and stamped metal. These industries draw their supply of copper at present almost wholly from the Lake Superior region or the Rocky Mountains. Their tin comes from over the sea, mostly from Cornwall, while the zinc is received largely from the Mississippi valley. The products of these works are shipped all over the country. In like manner the brass and iron hardware manufacturers have to a large extent congregated in the east. This was also true of the machine tool business for many generations. A new machine tool center was started some years ago in Cincinnati and some of the adjoining towns, so that today the Cincinnati machine and tool district is recognized. In like manner brass and bronze hardware specialty manufacturing concerns have gradually scattered all over the country, but the

majority of the wire and sheet metal industries still remain in the east. It seems to be absolutely certain that manufacturing interests must ultimately move westward as the center of population moves westward, especially since a large proportion of the raw material for many industries is to be found in the west. The difficulty has always been found in inducing skilled workmen to move, but this has been overcome in two ways in many cases.

First, by inducing a few skilled workmen to go to the new location and train local help to do the work.

Second, by changing the methods of manufacture, using machinery to a greater extent, and breaking in local help almost entirely.

The success attending these two methods depends largely upon the condition of the business.

The best copper in the world is obtained on the great lakes and both zinc and lead of very fine quality are produced in Wisconsin. The finest electrolytic copper is produced in Montana, and as these metals form the basis for many industries it seems natural that this industry would congregate where a fine shipping point could be had. There are two centers for such industries, one is to be found in St. Paul, and the other at the head of the great lakes at Duluth. The Minneapolis and St. Paul location has the disadvantage of being reached by rail only, while Duluth has the advantage of water transportation, and also practically as good shipping facilities as a distributing point as those possessed by any point on the Mississippi river.

For this reason Duluth will ultimately be selected as the center for many industries in connection with the brass and iron trades, and especially for the manufacture of hardware and brass goods. The growth of Duluth has been remarkably rapid, and it will undoubtedly be very greatly assisted by the fact that the Great Northern Power Co. has recently harnessed a portion of the rapids of the St. Louis river. The plans when fully carried out will develop over 200,000 horsepower. The present plans develop some 50,000 odd horsepower. This power will be available for manufacturing purposes during the coming year. The citizens of Duluth are making every effort to induce manufacturers to locate there. The climate of Duluth is delightful. The winters are cold but dry and healthful, while the summers are exceedingly enjoyable. We feel sure that during the next few years there will probably be built in this region an extensive series of manufacturing industries, including both iron and brass lines.

Remember the A. F. A. convention, Cleveland, June 4 to 7.

A New Book.

"The Commercial Management of Engineering Works," by Francis G. Burton, A. S. A. A., published by the Scientific Publishing Co., Manchester, England.

English price 12s 6d net. The work is 5½ inches x 8¾ inches and contains 430 closely printed pages, illustrated with a large number of diagrams, tables, business forms, etc. The author is an expert engineering accountant, who has had many years of practical experience, and in the work he has attempted to answer the many inquiries which have come up in his own experience. The book is very well written indeed, and contains many useful suggestions. The fact that it applies to British conditions rather than to American, however, does not make it of as much value to the American reader as would otherwise be the case. We believe, however, that all who are interested in this subject will find this book one well worthy of a careful reading.

The Joseph Dixon Crucible Co., of Jersey City, N. J., are sending out a very seasonable piece of advertising literature, entitled "Spring Painting." It consists of tastily arranged four page folder, describing the Dixon paint and setting forth some of its uses.

THE PATTERN SHOP

THE TOOL HOLDER IN THE PATTERN SHOP.

BY H. N. TUTTLE.

While nearly every pattern shop is equipped with one or more modern machine lathes, with compound feed, the majority of shops still use only the hand forged lathe tools.

Now if one should step into any machine shop, he would see that almost every lathe has one or more tool holders, according to the class of work done on the machine.

That there are many advantages in these tool holders, over the forged tools is evidenced by their being so universally adopted in the machine shop, and they will be found as useful in the pattern shop as in the machine shop.

In the first place, the forging of the original tool is generally entirely done away with, the tool being made by grinding the small piece of square steel to the required shape. Most tools can be sharpened at both ends, thus making a right and left hand tool in one, or a keen edge on one end for turning wood, with a blunter one on the other for turning metal. The tool being set into the tool holder on an angle, sufficient rake is obtained without grinding or forging the upper surface of the tool.

Then on account of the small amount of steel required for each tool, self-hardening steel can economically be used. This is of especial advantage in a shop where the workmen are careless about burning the tools when grinding, or where the tempering forge is a long distance from the pattern shop, or where for any reason it is inconvenient to get the tempering done. The self-hardening steels have been so greatly perfected within the last few years, that now tools may be made of them which will hold an edge longer than those made of common tool steel.

These tool holders are ever so much more rigid than the forged tools, as they are generally made for the pattern shop.

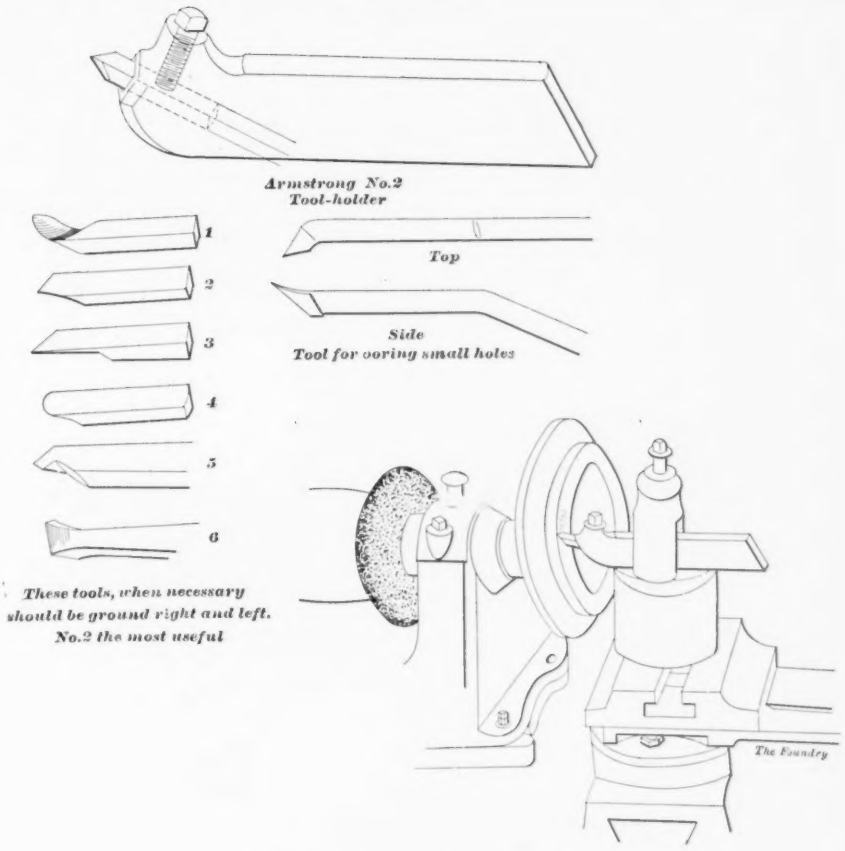
There are several styles of patent tool holders on the market, the "Armstrong" being one of the oldest, simplest, and best. One of the smallest sizes using ⅜-inch square steel is about right for the average lathe with tail stock, while one of the largest sizes using ½-inch square steel should be used for the large face plate lathes.

The holder for this latter lathe, and also for the former, if there be much deep segment work turned upon it, should be lengthened by welding a piece of steel to it, the ones upon the market for machinists' use not being long enough for this class of work.

It will be noticed that nearly all modern lathes are fitted with a swivel head stock. As remarked in a recent number of *Wood Craft*, very few pattern makers ever make use of this feature. In fact, the author of the article referred to said that he would be glad to have some one inform him what the device was for, anyway, or words to that effect.

Probably its chief use is in turning draft upon segment work, either inside or out, where the pattern is too deep to allow of its being turned its entire depth with one cut of the compound feed. This feed is never over a few inches in length, and if the pattern happens to be deeper than this, the turning has to be done piece-meal, as it were, if the draft is turned with the compound feed. With the head stock swiveled, the draft may be turned with a single cut, using the main straight feed.

The disadvantage of using this scheme



THE TOOL HOLDER IN PATTERN WORK.

is the uncertainty of the setting, which may be overcome entirely by graduating the outer end of the head stock, so that one space of the graduation gives 1-16-inch draft for 12-inch depth, or one degree, or any convenient scale. With a lathe graduated in this manner, draft may be computed and the lathe set with the same ease and certainty as with the graduated compound feed. This will appeal to anyone who has turned deep face-plate work with the short compound feed.

SAWING BEVEL GEAR TEETH.

BY N. A. WHEELER.

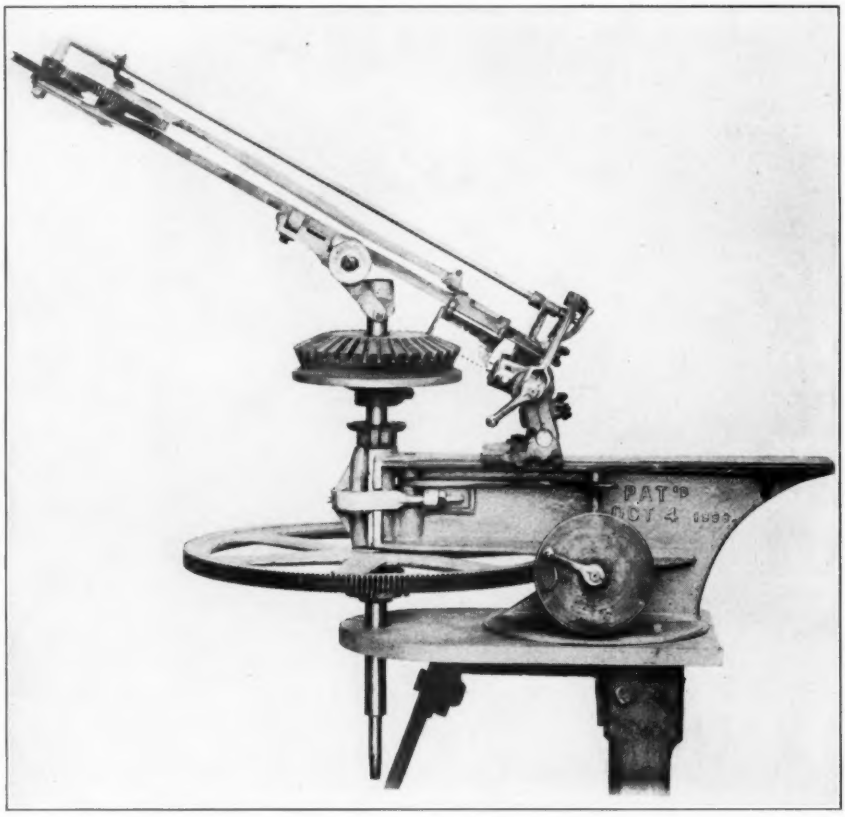
We have received a letter and description of a novel gear sawing machine from Mr. Wheeler, which we believe would be an exceedingly useful adjunct to the pattern machinery equipment of any pattern shop.

Mr. Wheeler states that he has been making patterns since the civil war and finally came to the conclusion that there was a faster and better method for making them than to whittle them out by hand.

The following description was sent in by the writer:

"I do have to smile when I read about making beveled gear patterns with a band saw. This method may fill the bill, but I am not prepared to say anything about it, as I never saw a pattern made in this way. Such patterns may be perfection itself and turned out rapidly, but a considerable amount of skill is required and the ability to work very close.

The machine, a photograph of which I am sending you, will do a very large variety of work. Recently I made a beveled gear pattern 12 inches in diameter, with 60 teeth, as a hurry up job.



BEVEL GEAR SAWING MACHINE.

It was turned from California red-wood, the teeth cut and the pattern completed in two hours and thirty-five minutes."

(Note.—Mr. Wheeler sent two sections cut from this wheel to the editor of THE FOUNDRY, and we may say that they show a very good class of work, and it is remarkable that such an accurate gear pattern could be finished in such a short time.)

"It makes me laugh to think of anyone monkeying with a band saw when better results could be obtained in less time with a special machine of this kind. The general construction of the machine is shown plainly in the illustration. The stock for the gear is glued up, attached to the face plate, and the face plate then transferred to the lathe, where the gear blank is turned up. If the teeth are to be attached separately, the face plate is then returned to the machine and laid off by means of the indexing head. The teeth are then secured in position, after which they are cut to the proper shape by the saw shown in the illustration. The machine is so constructed that the edge of the saw travels on a line, passing through the apex of the cone of the gear. The saw is governed in its travel by an ordinary tooth former, such as is used on standard gear cutters. Such a former can be laid out and cut from sheet steel very quickly. For a hurry up job, to be used but once, the teeth can be sawed from solid lumber without attaching separate pieces and the pattern thus completed in a very short time.

"Special attachments have been fitted to this machine for sawing skew gears and also for sawing mitre gears, with the teeth on a curve. These gears are sometimes called skew beveled gears.

"One advantage of the machine is that, once it is set up, it is practically fool proof and the apprentice boy or anyone else who can be trusted to turn the in-

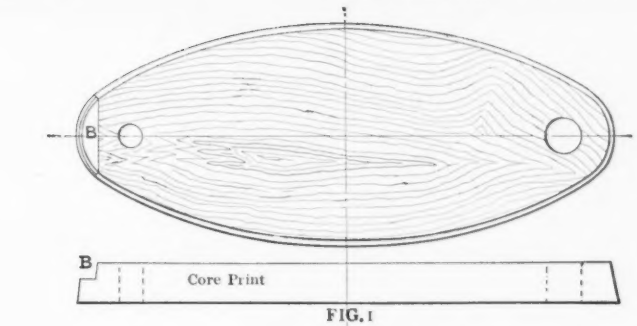


FIG. 1

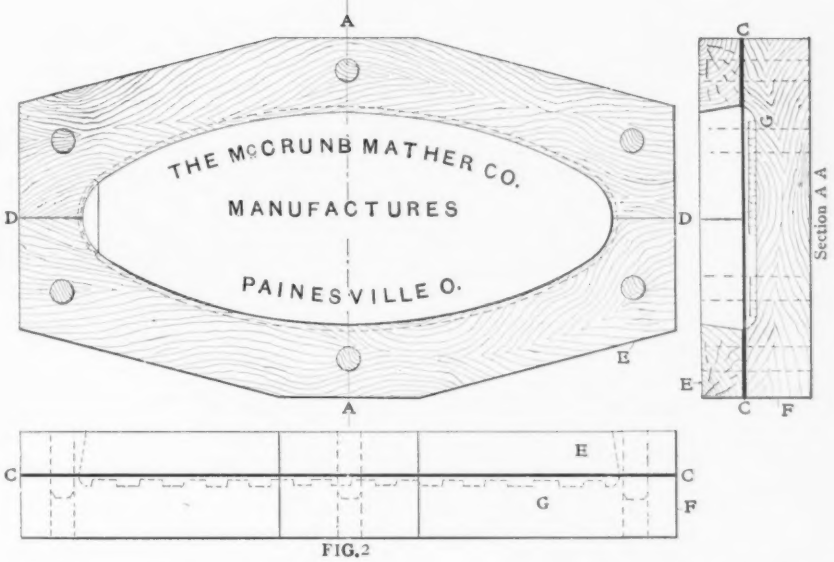


FIG. 2

dex crank and operate the sawing crank can produce a good gear pattern."

Mr. Wheeler has a patent on this machine and is anxious to get someone to take it up and exploit it, as he is located away over the Rocky mountains in the golden west and realizes that such a machine should be manufactured in the east if it is to be placed in the market regularly.

CORING IN NAME PLATES.

The accompanying illustrations show a method employed in placing name plates upon engine beds, etc., and one which insures their non-removal except by chipping. The method consists of a slab core of any form made from a core box upon the bottom of which is the desired lettering. Fig. 1 shows the core print, in this case of an elliptical form, and secured to the pattern by two loose dowels of different diameter as shown, in order to avoid placing the core print in the reverse position. A marker "B" is also required upon the print and in the core box, to insure placing the core in its correct position in the depression left vacant by the core print. Fig. 2 shows the general arrangement of core box which is parted on the lines "C C" and " D." The frame or print portion "E" having been gotten out to conform to the core print shown in Fig. 1, it is placed upon the bottom board "F" and secured with dowels, and its elliptical outline is scribed thereon. The surface enclosed by this outline is now backed out or depressed to the required depth "G" (which is usually the thickness of metal letter used) and the metal lettering is attached in the ordinary manner.—H. J. McCaslin in *The American Machinist.*

Chords of Angles from One to Ninety Degrees

Dimensions given in Inches

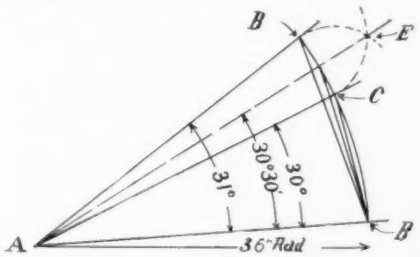
Ang.	18" Radius.	36" Radius.	72" Radius.	Ang.	18" Radius.	36" Radius.	72" Radius.	Ang.	18" Radius.	36" Radius.	72" Radius.
Deg.	Chord.	Chord.	Chord.	Deg.	Chord.	Chord.	Chord.	Deg.	Chord.	Chord.	Chord.
1	5/16	5/8	1 1/4	31	9 5/8	19 1/4	38 31/64	61	18 17/64	36 35/64	73 5/64
2	5/8	1 1/4	2 1/2	32	9 59/64	19 27/32	39 11/16	62	18 35/64	37 5/64	74 1/64
3	15/16	1 7/8	3 3/4	33	10 7/32	20 5/64	40 57/64	63	18 53/64	37 5/8	75 1/4
4	1 1/4	2 1/2	5	34	10 17/32	21 3/64	42 3/32	64	19 5/64	38 5/32	76 5/16
5	1 37/64	3 9/64	6 9/32	35	10 53/64	21 21/32	43 19/64	65	19 11/32	38 15/16	77 3/8
6	1 57/64	3 39/64	7 3/32	36	11 1/8	22 1/4	44 1/2	66	19 39/64	39 7/32	78 27/64
7	2 13/64	4 5/64	8 51/64	37	11 27/64	22 7/32	45 11/16	67	19 59/64	39 47/64	79 1/32
8	2 1/2	5 1/64	10 1/64	38	11 23/32	23 7/16	46 7/8	68	20 1/8	40 17/64	80 17/32
9	2 53/64	5 41/64	11 39/64	39	12 1/64	24 1/32	48 1/16	69	20 25/64	40 25/32	81 15/16
10	3 29/64	6 9/32	12 35/64	40	12 7/16	24 5/8	49 1/4	70	20 51/64	41 1/64	82 1/32
11	3 3/4	6 31/32	13 51/64	41	12 49/64	25 7/32	50 7/16	71	20 29/32	41 13/16	83 5/8
12	3 49/64	7 17/32	15 3/64	42	12 29/32	25 51/64	51 39/64	72	21 5/32	42 21/64	84 1/4
13	4 5/64	8 5/32	16 1/64	43	13 3/16	26 25/64	52 25/32	73	21 13/32	42 53/64	85 1/32
14	4 25/64	8 25/32	17 35/64	44	13 31/64	26 31/32	53 15/16	74	21 25/32	43 31/64	86 3/32
15	4 53/64	9 5/64	18 51/64	45	13 25/32	27 35/64	55 7/64	75	21 57/64	43 53/64	87 1/8
16	5	10 1/64	20 1/32	46	14 1/16	28 1/8	56 17/64	76	22 5/32	44 21/64	88 11/32
17	5 21/64	10 11/64	21 9/32	47	14 13/64	28 23/32	57 27/64	77	22 19/32	44 53/64	89 3/64
18	5 5/8	11 17/64	22 13/32	48	14 11/64	29 9/32	58 7/64	78	22 23/32	45 5/16	90 5/8
19	5 15/16	11 7/8	23 49/64	49	14 29/64	29 55/64	59 3/32	79	22 61/64	45 51/64	91 1/32
20	6 1/64	12 1/2	25	50	15 7/32	30 27/64	60 55/64	80	23 7/64	46 9/32	92 1/16
21	6 9/16	13 1/64	26 1/64	51	15 1/2	31	62	81	23 3/8	46 3/4	93 3/64
22	6 7/8	13 47/64	27 31/64	52	15 25/32	31 9/16	63 1/8	82	23 39/64	47 5/64	94 15/32
23	7 1/64	14 7/64	28 15/64	53	16 1/16	32 1/8	64 1/4	83	23 55/64	47 55/64	95 3/32
24	7 31/64	14 31/32	29 15/16	54	16 11/32	32 11/16	65 3/8	84	24 3/32	48 11/64	96 23/64
25	7 47/64	15 27/64	31 11/64	55	16 7/8	33 1/4	66 1/2	85	24 7/32	48 41/64	97 9/32
26	8 3/32	16 13/64	32 25/64	56	16 29/32	33 51/64	67 39/64	86	24 31/64	49 3/32	98 13/64
27	8 1/2	16 1/8	33 5/8	57	17 11/64	34 23/64	68 27/32	87	24 55/64	49 1/16	99 1/8
28	8 15/64	17 13/32	34 13/16	58	17 29/64	34 29/32	69 13/16	88	25	50 1/64	100 1/32
29	9 1/64	18 1/32	36 1/16	59	17 23/32	35 29/64	70 29/32	89	25 15/64	50 1/32	100 15/32
30	9 15/64	18 41/64	37 17/64	60	18	36	72	90	25 29/64	50 33/64	101 53/64

CORDS OF ANGLES,

BY H. J. MCCASLIN.

The accompanying table of cords of angles will be found very useful in many operations in both the foundry and pattern shop. It will also tend to do away with much inaccuracy which is usually the result of laying out angles which extend beyond the line of the protractor blade.

To obtain the cord of any angle given in the table scribe an arc of a circle with one of the radii given. With the trammel lay off the cord of the required angle point the circumference scribe. Now if lines be drawn through the ends of the cord to the center of the circle they will represent the angle desired.



CORDS OF INTERMEDIATE ANGLES CAN BE OBTAINED AS SHOWN ON THIS DIAGRAM.

Cords of intermediate angles not given in the table can be obtained by dividing the difference between two given angles, as shown in the diagram.

Example.—It is required to lay out an angle of 30 30′. First: Draw with a radius of 36 inches an arc BB. The base line AB is drawn passing through the center of the circle, and by referring to the table the cord at the angle of 30 upon the 31 inch radius is found equal to 18-41-64 inches. With this length set off on the trammels the cord BC is laid off. The cord of 31 is found to be equal to 19 15-64 inches with a trammel set to this distance and B as the center, the cord is drawn through D. Next, with the dividers set to any convenient radius the cord CD is bisected and the line drawn through the points E and A will give the difference between the two angles, and the angle BAE will equal to 30 30′.

Notice:—Reports of any errors detected in this table will be greatly appreciated by the writer.

MEETING OF THE CLEVELAND PATTERNMAKER FOREMEN'S ASSOCIATION.

On Tuesday evening, April 17, the patternmaker foremen of Cleveland and vicinity met in the offices of the Penton Publishing Co., in the Browning Bldg. The entire evening was given up to the discussion of matters relative to the A. F. A. convention and a committee arranged for, who are to prepare a joint paper on "Pattern Shop Equipment," to be read at the meeting of the American Foundrymen's Association convention in Cleveland, June 5 to 7.

The pattern shop and pattern shop equipment will be thoroughly discussed at the coming convention of the American Foundrymen's Association and the Associated Foundry Foremen in Cleveland, June 4 to 7. See that as many foremen patternmakers as possible attend, as well as the man who pays the bills.

TRADE PUBLICATIONS.

The Expanded Metal & Corrugated Bar Co., St. Louis, Mo. has issued a catalog 7 x 5 inches, containing 232 pages of exceedingly interesting and valuable matter relative to reinforced concrete construction. The catalog is illustrated by many half tones and line drawings, and contains valuable formula and engineering data. We cannot see, however, why the catalog could not have been made standard size to conform with the publications of most manufacturers.

The Brady Bros. Co., of 200-212 Tenth st., Jersey City, N. J., have issued a catalog 6 x 9 inches, in which it describes cyprus brands journal bearings for locomotives and cars, together with other brands of bearing metal and solders manufactured by this company.

METALS IN FOUNDRY PRACTICE

Devoted to inquiries from Practical Foundrymen on subjects relating to the Melting and Using of Cast Iron, Malleable Iron and Steel.

The following experts answer questions in this department:

W. J. Keep, Cast Iron.

J. B. Nau, Metallurgy of Steel and Steel Castings.

Dr. Richard Moldenke, Malleable Castings.

We have also made arrangements with several others to act as special contributors. All inquiries should be addressed to the Editor of THE FOUNDRY, and they will then be forwarded to those in charge of the different subjects.

CAST IRON NOTES.

BY W. J. KEEP.

GOOD MELTING IN AUSTRALIA.

Inquiry.— Our cupola measures 18 inches inside of the lining. The tuyeres are 21 inches above the sand bottom and are five inches in diameter, one on each side. The cupola is 18 feet high with the charging door 10 feet from sand bottom.

The blast is from a 30-inch fan having 11-inch diameter air outlet and driven by a 4-horsepower steam engine.

There is a slag hole slightly lower than the tuyeres, which, when the furnace is running is opened after the eighth charge.

We light the fire at 4 A. M., put in coke to reach 20 inches above the tuyeres and put on first charge of iron about two hours after the furnace is alight.

The charges are 112 pounds iron to 18 pounds of hard coke and so on all through the day until we stop work at 4 P. M.

We make during one day's run from 1,700 to 2,800 pounds of light castings and about 11,000 pounds of plow shares cast in chills. We make three casts a week.

We use one-half plowshire scrap and one-half No. 1 gray hematite pig.

Our trouble is with the first three or four charges which are not hot enough to run and this iron has such a high shrinkage and is so hard that we cannot use it.

Answer.—The bed of coke as they give it would weigh 216 pounds. There would be 122 charges of coke and 123 charges of 112 pounds of iron. The melting ratio would be about 6.25 to 1 and about 1,500 pounds per hour. No trouble is reported after the first 350 pounds of iron is out of the cupola. Considering that this 18-inch cupola runs nine hours, this is a remarkable record. It seems as though there must be some mistake in the report.

Now, as to the dull hard iron, the report says that the bed, when the fire is lighted, is 20 inches above the tuyeres and that it burns two hours. Nothing is said about adding any more fuel until after the first charge of iron has been put on. After full two hours' burning enough coke should be added to reach at least 15 inches above the tuyeres before the first charge of iron is added. The cupola must be hot with plenty of bed. This should make the first iron as hot as any. The first iron will have considerably more shrinkage than that which comes down later because the cupola is not so hot and for no other reason. It would be better to use very little scrap on the first three heats or else add enough high silicon iron to take out the shrinkage, soften the iron and make it fluid.

ALUMINUM IN CAST IRON AND STEEL.

Inquiry.—I have been trying to get a metal that is tougher than gray cast iron and fluid enough to run into very thin castings. I have added steel scrap to cast iron until the castings were white, but they were brittle. I tried to soften with aluminum until the chill was gone but the castings had no strength.

What percentage of aluminum could I add to make a semi-malleable casting. Is there any other way to make such thin castings tough?

Answer.—This kind of iron is what we all want. For very thin castings the only way is to use pig iron that will of itself make tough castings and then add high silicon iron until it is fluid enough to run the castings. I do not known what you consider very thin castings. The addition of steel scrap

decreases the fluidity of the melted iron. Fifteen per cent of steel scrap would probably be the limit and you can make it more fluid by adding one-quarter of 1 per cent of aluminum or even less. This is semi-steel, but is not suitable for very thin castings.

One trouble nowadays with adding aluminum is that most shops use aluminum for patterns and other castings, but this metal is "casting aluminum," and cannot be used to soften cast iron or semi-steel. You should purchase pure aluminum, a piece of which ½ inch each way would soften 50 pounds of iron if dropped into the ladle of metal.

You could, from pig iron alone, make an iron mixture that would be soft and tough and which would bend considerable, but the trouble is to keep such a mixture uniform. A slight change in the coke used in melting, or a little difference in the pig iron purchased would make the castings hard and weak.

There is a limit as to what can be done with cast iron.

I do not know of any other metal that can be added to help matters.

STEEL FOUNDRY NOTES

BY J. B. NAU

GREEN SAND STEEL CASTINGS.

Inquiry.—Please let me know the best method of making steel castings in green sand. What kind of sand is used, also kind of blacking and how should the castings be gated?

Answer.—The best sand to be used in making steel castings in green sand is pure sharp silica sand with just enough clay to make it plastic.

Such molding sand is sometimes found in nature, but when it cannot be obtained as a natural product it may be made by mixing, say, two parts of sharp silica sand with one part of kaolin. Other mixtures can be made, providing the material resulting is refractory, plastic and open enough to allow the gases to escape.

Hard steel castings, that is, high carbon steel castings, can be made in a mold that is less refractory than that required for soft steel castings.

The finished mold is dusted or sprinkled over with ground refractory fire clay, ground or powdered old crucibles, or with powdered quartz.

The gates on a steel casting should be placed in such a manner that liquid metal is fed to any place separated from another gate by intervening thin parts. This is necessary on account of the fact that the thin parts always set more quickly than the heavy parts, and hence the steel has to be fed to these thick parts through specially prepared gates or risers. If no gates or feeders are provided for these isolated thick parts, they will contain blowholes or defects.

SMALL OUTPUT OF STEEL CASTINGS.

Inquiry.—We have to make castings that require strength, but at the same time must be light, such as gear wheels weighing from two to three hundred pounds. If possible, we would like to make these of steel, which, although more expensive in first cost, wear much longer. Can some one inform us if these light wheels can be made by the Martin Siemens Steel process, say in a furnace of five to six hundred pounds capacity? We have no gas in this country, and hence, would have to use wood, coal or coke. We have at our command scrap steel, ferro silicon, ferro manganese, spiegel-iron, also pig iron.

Answer.—Answering your subscriber's request in regard to steel work, the writer may say that the building of a small open-hearth furnace of the capacity of 500 pounds per heat, is out of the question, especially when it is considered that he wishes to make a few gear wheels and other small castings, which would require very hot metal. Under the circumstances, the best and probably only solution for him is to put up a small baby converter of 1,000 to 1,500 pounds capacity. This can be put in operation and stopped at any time he desires to do so. Of course, it is necessary to have a small cupola near the

convertor to furnish the molten iron. Such a proposition as this is cheap and effective as far as original installation is concerned.

The entertainment features in connection with the American Foundrymen's Association and the Associated Foundry Foremen's conventions will be unusually good. Cleveland, situated on the lake as it is, affords opportunity for a large variety of entertainment.

MELTING A SMALL QUANTITY OF STEEL.

The writer has installed at West E. K. in the April issue of THE FOUNDRY, concerning the melting of a small quantity of steel.

The writer has installed at West Drafton, England, a 60-inch Schwartz furnace for making malleable iron. This furnace melts 1,200 pounds at a time and takes one hour and thirty minutes for the operation. High carbon steel is also made in the same plant in Schwartz furnaces.

I would be glad to hear further from E. K. concerning his requirements.

E. H. SCHWARTZ.

HIGH MELTING RATIO.

Regarding the high melting ratio of R. P. several things are mentioned, as to size of cupola, tuyeres and wind belt etc. The tuyeres are 4 inches by 12 inches, which is 48 square inches for each, and 6 tuyeres give an area of 288 square inches. The wind belt is given as 8 by 14 inches, which is an area of 112 inches. While the blast pipe is only 13 inches in diameter, or an area of 132 inches. I would suggest that the blast pipe be made 20 inches in diameter, and that the area of the wind belt be increased. In this case you will find that the air will enter the cupola at a small velocity.

Now do not be horrified at the next suggestion. That is, to cast only once a week, for by so doing you will find your melting ratio as high as other people, and the iron as hot as it may be desired. The cupola is large enough for from 60 to 75 tons a day. With the present output it would be better to use a cupola of 36 inches in diameter, inside the lining, as this could easily produce from 20,000 to 30,000 pounds of iron at a heat.

CANUCK.

MOLDING SAND.[1]

BY H. E. FIELD.[2]

A review of current literature on molding sand brings to my mind a previous experience some ten years ago. I then pursued a like line of research upon the subject of cast iron. The results were as follows: one authority stated that silicon softened cast iron, another that silicon hardened cast iron; one that sulphur was the most injurious element in cast iron, another that sulphur was never present in sufficient quantity to do any harm; one that phosphorus increased shrinkage, another that phosphorus decreased shrinkage; one that manganese hardened cast iron, another that manganese softened cast iron; one that cast iron gained in carbon in passing through a cupola and another that cast iron lost carbon in passing through a cupola. Since that time all of these apparent contradictions in regard to cast iron have been explained.

A similar contradiction exists in the literature in reference to molding sand. This is partly due to a confusion in terms and partly to the marked difference of opinion as to what constitutes a molding sand. I shall endeavor to explain away this confusion in terms but it is not practical to give definite specifications for molding sand on account of the great variety of work and the different methods of mixing sand for the same work. I wish to make it clear, therefore, at the beginning of this paper, that I am not attempting to lay down a set of standards for the chemical or mechanical analysis of sand. The day for that may come, and when it does the sand question will be much simplified.

[1] A paper read before the Pittsburg Foundrymen's Association March 5, 1906.

[2] Chief Chemist, Mackintosh-Hemphill & Co., Pittsburg.

The present knowledge of the simple principles which go to make up a good molding sand is rather vague and any attempt to build specifications upon it would be like building a house upon quicksand. We will study in as comprehensive a manner as possible, first, the composition, and second the properties of a molding sand. If we would improve molding sand or reduce its cost, we must have a thorough understanding of what would constitute a model molding sand. We can then intelligently select the materials which nature has placed at our disposal and combine them so as to approach a standard, for I doubt if there is a founder present who can say that he has even come near to perfection in quality and economy in the molding sand which he uses.

We are continually told that the good molding sand of the old days can no longer be obtained, and that the present supply is fast disappearing. If this is true it behooves us to gain a knowledge of what is necessary to make up a good molding sand, so that when nature's supply is exhausted we can prepare a satisfactory substitute from her abundant supply of constituent materials. Let us consider the composition of nature's molding sand with this in view.

Composition of Molding Sand.

Molding sand is made up of two distinct and necessary components: First—silica in the free state, and second—silicate of alumina. The free silica gives grain, refractoriness, porosity and low shrinkage to the sand, while the silicate of alumina furnishes bond. Free silica would be useless without the silicate of alumina, as it would not hold together. Silicate of alumina would be worthless without free silica, as it would not have sufficient porosity, and would have too great a shrinkage.

A confusion exists in the use of the word "silica" in respect to sand, which I shall endeavor to avoid by designating the silica existing in the free state "quartz silica." This quartz silica has a definite set of properties. It is hard, crystalline and very refractory, while silica combined with the alumina has lost all its original properties which are merged into the properties of the silicate of alumina. This last compound is very soft and amorphous, and its refractoriness depends upon its purity. The name silica has become so attached to the kind of sand known as "silica sand" that it is almost impossible to separate them in the minds of foundrymen. If I should state that a sand contained 80 per cent silica, I might convey the impression to some that 80 per cent was pure silica existing as quartz silica, while in reality a part of this 80 per cent would be united with the alumina. The same misunderstanding occurs from the use of the term "alumina." The alumina is confused with the silicate of alumina, or clay which makes up the bond. I might say that a sand contains 10 per cent alumina. I would not mean that there was ten per cent of bond and 90 per cent of refractory material, but that about twice this ten per cent, or the total silicate of alumina, would make up the bond. This silicate of alumina will be referred to as clay or bond in this paper.

There are several other substances present in all sand. These impurities are not at all desirable and are present from necessity rather than from choice. Quartz silica and clay in correct proportions can constitute a good molding sand without the presence of any other substance.

We will consider the individual characteristics of the constituents which make up a molding sand for the correct combination of these properties determines the quality and grade of the sand. A knowledge of the effect of the impurities allows us to determine to what extent they may be present in a given sand and still do no harm.

Ingredients of Molding Sand.

Quartz silica, clay, iron oxide, lime and feldspar are the principal ingredients of molding sand.

Quartz Silica.—Pure quartz, or silicon dioxide consists of 46.67 per cent silicon and 53.33 per cent oxygen. It is very hard, fuses at a high temperature, has no cleavage, and when pure is white. It is, however, generally colored by some oxide of iron. Its fusi-

bility is affected by the amount of impurities present.

Quartz is the chief non-shrinkage element in molding sand. By this I mean that its size is not greatly affected by heating and cooling. It has however, no bonding properties. The shape of its particles affects the strength of the sand, but they have no strength in themselves, as quartz is absolutely non-plastic. The properties of a molding sand influenced by quartz silica are refractoriness, porosity and shrinkage. The size of the quartz grains determines the grade of the sand.

The percentage of quartz silica present varies in different grades of molding sand. The more refractory sands are generally higher in quartz silica, averaging from 60 to 70 per cent. (This must not be confused with the total silica.) The percentage best suited for a sand can only be determined by the kind of work for which it is used. The quartz silica should be kept as high as possible, on account of its heat resisting power, its tendency towards porosity and its low shrinkage.

Bond or Clay.—The bond of a molding sand is a clay product. Pure clay or kaolinite is a hydrated silicate of alumina; that is, a silicate of alumina containing water of combination. The exact composition of pure clay is silicon dioxide, or silica 46.4 per cent, alumina 39.7 per cent, water 13.9 per cent. It is this 13.9 per cent of combined water which gives the plastic properties to the clay. The part played by the water in adding plasticity is a matter for conjecture. This combined water is driven off at high temperatures and when it is thus driven off the bonding power of the clay is destroyed. The bond of a molding sand is not pure clay, but is generally mixed with impurities which weaken its binding power. Clay is formed by the decomposition of feldspars. These are rocks containing silicate of alumina together with silicates of the alkalies. After the rocks are decomposed, more or less of the alkalies are washed out by nature's agencies, the amount remaining determining the purity of the clay, and hence its value as a refractory and bonding medium.

The clay acts as a binder for the sand and holds the refractory quartz silica together. The purity and plasticity of the clay determines the amount necessary to give a sand its correct bonding strength. The clay when pure is very refractory, and it is a fallacy to think that because there is a large proportion of bond in a sand that it is low in refractory qualities. A high percentage of clay in a sand destroys its porosity and causes high shrinkage and consequently cracks. The percentage of clay differs in different sands. A sand should be chosen with as low a clay content as is consistent with shop conditions. In foundries where a large percentage of old sand is used it is absolutely necessary to use a new sand containing a high percentage of bond. This is not conducive to the best results. There are, however, certain classes of work, the appearance of which must be sacrificed to cheapness of material, and such conditions require that a large amount of old sand be used in the facings. When a lower proportion of old sand is used, a new sand with less bond, and consequently higher quartz silica will give a more porous facing.

As previously indicated the percentage of clay should not be figured from the percentage of alumina present, as all sand contains feldspar which in turn contains alumina. This alumina in the feldspar has absolutely no bonding power.

Feldspar.—Feldspars are silicates of alumina combined with silicates of the alkalies. These are generally present in small amounts in molding sand, but they should be kept as low as possible on account of their fusibility as they tend to flux the rest of the sand and bind it together.

Oxide of Iron.—Oxide of iron is present in all molding sand giving it its reddish color. It may be united with the bond as an impurity, or it may form a part of the quartz silica. In either case it lowers the fusing point. The iron comes into the sand either from the original rocks from which the

sand was formed or from water containing iron which has trickled through the sand.

Lime.—Lime is sometimes present in molding sand. It makes the sand fusible and liable to crack and crumble in the mold. It may come from the water which has aided in the decomposition of the rocks during the formation of the sand. The proportion and condition of the above products determines the quality of the molding sand, and vice versa, the properties of a molding sand are wholly dependent upon the percentage and condition of these products. We have noted in our remarks concerning silica and alumina that the ultimate chemical analysis and the properties of a molding sand do not necessarily correspond. Chemical analysis is, however, very useful in detecting injurious substances.

There is a method of analysis called "rational analysis" which has been used on clays and which gives a more correct idea of the constituents of a molding sand than does ultimate analysis. This separates the sand into three substances, quartz substance, clay substance and feldspar. I do not intend to go deeply into this phase of sand analysis, but rather to indicate it as a subject for further investigation which may prove very fruitful.

Analysis of Molding Sand.—The ultimate analysis of a good molding sand will give results within the following limits.

Total silica	75 to 85 per cent
Alumina	7 to 10 per cent
Lime below	2 per cent
Alkalies below	0.5 per cent
Oxide of iron below	6 per cent

The total percentage of iron oxide, lime and alkalies, or the total fluxing agencies should not ordinarily exceed 7 per cent in one sample. In a high grade molding sand used for heavy work they should not exceed 5 to 6 per cent.

A sand analyzed by the rational method should give a quartz silica of from 60 to 70 per cent, a clay content of from 20 to 30 per cent, with a feldspar below 10 per cent. If the iron was determined separately and subtracted from the clay content with which it is included by this method, we should have a fair indication of the properties of a molding sand as far as its refractoriness is concerned. The strength is so dependent upon the purity and condition of the clay that it cannot be accurately gauged by any analysis.

Two molding sands, one a so-called strong sand and the other a rather sharp sand, both of which would be classed as a No. 4, give the following results by ultimate and rational analysis.

SHARP MOLDING SAND.

Ultimate Analysis.

Silica	80.66
Alumina	9.30
Iron Oxide	4.53

Rational Analysis.

Quartz Silica	67.85
Clay content, including iron oxide	22.03
Clay content, excluding iron oxide	17.50
Feldspar	10.12

STRONG MOLDING SAND.

Ultimate Analysis.

Silica	77.22
Alumina	9.26
Iron Oxide	5.56

Rational Analysis.

Quartz Silica	64.66
Clay content, including iron oxide	28.06
Clay content, excluding iron oxide	24.50
Feldspar	7.28

Properties of a Molding Sand.

Sand can be used for making molds if it is refractory, porous, strong and of a correct grain.

Refractoriness.—The elements which determine the refractoriness of a molding sand are its silica or quartz contents and its clay or bond contents. As stated under "Compositon" the quartz when pure is very refractory, as is also the clay or bond content of a certain composition. It is, however, more difficult to obtain a sand with a bond of the correct composition than it is to obtain a sand containing silica which is comparatively pure. It follows therefore, that the higher the percentage of quartz a sand contains the greater will be its refractoriness. Consequently when a sand of high refractory qualities is desired, one should be chosen which contains as high a percentage of quartz

silica as possible and still have sufficient bond to hold the sand together. Some sands high in clay contain a bond of sufficient purity to have a high fusing point. Such sands, however, are the exception.

The impurities which impregnate a molding sand greatly reduce its refractoriness. They may enter into the sand as an impurity associated with the quartz or the bond, and thus greatly reduce the refractoriness of these two principal ingredients, or they may enter in as an independent mineral substance which of itself fuses and holds the other constituents of the sand together. The sodium and potassium salts in the form of feldspars and mica are constituents of all clays to a greater or lesser extent, and consequently form a part of all molding sands. These alkalies, fusing at a low temperature may bind the rest of the substances into a hard mass. Iron oxide also increases the fusibility, as does lime which is occasionally present. This latter is most harmful when present as a carbonate, as a gas would be given off at a high heat which would prove detrimental to the mold.

The size of the grain of a sand may affect its refractoriness. Several experts on clays have demonstrated that under certain conditions the fusing point of the clay is determined by the size of the grain. It is therefore probable that the same holds good in regard to a molding sand, the larger grained sand having a higher fusing point.

The four principal factors pertaining to high refractoriness are: first, a high percentage of pure quartz silica; second, refractory form of clay bond; third, a freedom from harmful impurities; fourth, a comparatively large grain.

Porosity.—Some sands are naturally porous while others are very impervious to gas and moisture. The porosity of a sand determines the amount of venting necessary. Some sands must be vented very freely for all grades of work, while with others the use of a vent rod is hardly necessary. There are four factors which determine the porosity of the sand; first, the proportion of quartz silica to the bond; second, the size of the quartz silica particles; third, the shape of the quartz silica particles; fourth, the condition of the bond.

Proportion of Quartz Silica to Bond.—Generally speaking the higher the proportion of the quartz silica the greater will be the porosity of the sand. These particles are crystalline, ragged and irregular in shape and are in comparatively large grains, while the clay or bond is a very fine powder. It is plain, therefore, that inasmuch as the porosity of the sand is a very important feature, the percentage of the quartz particles should be kept as large as possible and still retain the other properties necessary to a molding sand. Quartz silica has no bonding power so there is a limit to the percentage which may be present.

Size of Quartz Silica Particles.—The larger the quartz particles the more porous will the sand be. It will be apparent, however, that the size is limited from the fact that a sand cannot be too coarse and still give a finish to the casting. The particles should, therefore, be kept as large as possible, and still produce the desired effect as to finish. There is another phase of this question which must be kept in mind, viz., that what appears to be a coarse sand may really be a mixture of fine and coarse. The fine particles mixed between the large ones and filling in the spaces will lower the porosity. A little thought will convince one that a sand containing comparatively fine particles of a uniform size will give a much more porous whole than will a mixture of coarse and fine grains. We have noted that the quartz grains should be kept as large as possible and still give a good surface to the casting. The converse is also true, viz., that the quartz particles should be kept as fine as possible and still give the required porosity. This latter condition is only found in sands with quartz particles of a fairly uniform size.

Shape of Quartz Silica Particles.—The porosity is also affected by the shape of the quartz silica particles. Ir-

regular crystalline structures with sharp edges and corners will leave greater spaces between the particles than will regular particles with smooth surfaces which are apt to fit closely together and thus prevent a free passage of gas or air.

Condition of the Bond.—We have noted under refractoriness that the percentage of quartz silica should be as high as possible and still have sufficient bond for the work for which the sand is used. The amorphous condition of the bond or clay would tend to fill up the openings in the sand and reduce the porosity. The less the proportion of bond used, and still having sufficient binding power in the sand, the greater will be the porosity. It follows, therefore, that the stronger the bond, the less the quantity necessary to produce the same results, consequently the sand having the strongest bond requires the lowest percentage of bond. A low proportion of bond means a high percentage of quartz silica, and a high porosity. Consequently sands having strong bonding material rather than a large percentage of bond could be superior as far as porosity is concerned. It is this feature which more than any other distinguishes a good from a poor molding sand. There are certain molding sands found in nature which are what we would term sharp, and they still have sufficient bond for molding purposes. It is the strength of this small proportion of bond which permits of this being possible.

The tendency of clay to bake together and destroy the porosity of the sand and its tendency to crack, due to excessive shrinkage when drying renders the presence of a large amount of clay bond objectionable. It is very necessary that a sand be chosen with a low percentage of strong bond rather than a large percentage of weak bond.

Strength.

The strength of a molding sand determines its adaptability for different kinds of work. Some castings may be made with sand having comparatively little strength, while for others a strong sand is absolutely necessary. The amount of strength necessary is somewhat dependent upon shop practice. The methods of molding, ramming, venting and mixing of the sand must all be considered in determining the proper strength of a sand for a given class of work. The practice of using flour, molasses or clay wash in mixing up facing, together with the proportion of coal dust and old sand used is also an important factor to be considered in the choice of a sand. In foundries where nailing is generally resorted to a weaker sand may be used than where nails are not used. A good mechanical mixer which intimately surrounds each particle of old sand with particles of new sand rather than putting the old and new sand together in chunks, also permits the use of a sharper sand. Where flour or molasses is used, or where the proportion of old sand to new sand is comparatively small, the use of a sharp sand is possible.

The strength of a sand depends upon three conditions; first the proportion of bond; second the strength of the bond; and third the shape of the quartz silica particles.

Strength of the Bond.—It follows other things being equal, that the greater the strength of the unit of the bond, the greater will be the stength of the sand. Under previous headings we have noted that the less the proportion of bond present in a given sand which still has the required strength, the better will be the other qualities of the sand. Consequently the stronger the bond the better the sand. There is but one argument in favor of a weaker bond used in larger proportions, viz: that it is much easier to distribute a large amount of bond over the whole, so that a sand with a larger percentage of a weak bond might be more uniform than a sand with a small percentage of strong bond. Uniformity is a very important property of molding sand. A good mechanical mixer however will generally do away with any lack of homogeneity.

Proportion of Bond.—Under porosity I have called attention to the difference in strength in the clay constituents. It follows that the strength of a sand will depend upon the amount

of bond present if the strength of the bonds are equal.

Shape of the Quartz Silica Particles.—The shape and size of the quartz silica particles has an important bearing on the strength of a sand. Sands with quartz particles having a rough jagged exterior will be stronger than sands having smooth quartz particles. The rough surfaces would interlock in the first instance while in the second case the smooth sides would offer but little resistance to separation. The relative size of the quartz particles also affects the strength. The strength appears to be greater when there is a correct proportion of large and small particles. This condition exists when the particles are of such size and shape as to give a compact mass.

Size of Grain.—The grade of a molding sand is determined by its grain. The finer grained sands are used for the lighter work. Sands are graded and sold by numbers based upon the size of the grain.

There are several factors which determine what grain of sand is most suitable for a given class of work. Some of these have been referred to under previous headings and need but a passing mention here. A sand should be as fine grained as possible and still satisfactorily fill the other requirements of a molding sand. This is due to the fact that the finer grained sand will give a better surface to the casting. The grain of the sand is determined largely by the grain of the original rock from which the sand was formed. The fineness of the sand is obtained quantitatively by the use of a series of sieves, 100, 80, 60, 40, and 20 mesh sieves being used. A weighed amount of the dried sand is placed in the 100 mesh sieve which is shaken for a definite time, say one minute. The siftings are carefully weighed and the weight recorded. The 80, 60, 40 and 20 mesh sieves are used in the same way. These separate weighings are multiplied by the number of the mesh of the sieve. There is a certain loss due to dust flying, etc., which is found by subtracting the total of the weights obtained from the original weight. This loss is multiplied by the average mesh of the sieves which is 60. The sum of the products of the weights obtained by the number of the sieves divided by 100 constitutes what is known as the "degree of fineness" of the sand. This method is unsatisfactory in many ways, as all sands of the same "degree of fineness" do not have the same physical effects when used as a molding sand. This is due to the fact that the proportion of sand which passes through each sieve has an important bearing upon the quality of the sand. We noted, under porosity, that a sand whose particles were all small but of uniform size would give better results than one with a combination of large and small grains which might be of the same "degree of fineness" when judged by the standard sieves.

It is never advisable to judge of the fineness of a sand by its appearance, for a comparatively few large particles will give the whole sand the appearance of being coarse while in reality it may be very fine when judged by the standard sieves.

In considering fineness we cannot lose sight of the other essential properties of sand. We have noted that of two sands of different size grains, the fine grained sand will fuse first; that a combination of large and small grains produced a sand of low porosity; that sands of equal sized grains gave a porous sand, and that sands with a correct proportion of large and small grains gave a strong sand. These facts oppose each other to a certain extent.

In selecting a sand for a given grade of work the sand should be kept as fine as possible and still be sufficiently porous and refractory. In order to be sufficiently porous and refractory and still be fine grained, the particles should be of as uniform a size as possible and still have sufficient strength.

Conclusion.

We have looked at molding sand from two view points. First as a study of the materials which go to make up a molding sand, and second as a study of the properties which are necessary and most desirable in a molding sand. A thorough understand-

ing of the principles considered, should aid us in intelligently selecting the best sand for our individual use.

Let me remind you that what proves to be a good sand in one foundry may prove just the opposite under the differing conditions of another. It is with this fact strongly in mind that I give you general information rather than specific data which might apply to one set of conditions.

Under "Composition" I have classified the properties of the different ingredients of molding sand. Under "Properties of Molding Sand" I have endeavored to call attention to the different properties necessary to a molding sand, and have shown the possibilities as well as the limitations in choosing or making a sand for foundry use.

Judging from large number of foundrymen we have heard from, who intend to be present next June, it is evident that it is going to be an old-time gathering, with a large attendance.

CRUCIBLE STEEL.

BY R. BARRANGER.

Mention "Steel" and the majority of persons only ordinarily versed in metallurgy immediately think of the Bessemer or open-hearth process, and with good cause. For, not only are these two methods the largest producing ones, but are those on which many, many articles have been written, whereas it is difficult indeed to find a ready reference on the crucible process.

This process, though one of the oldest, is the one in which the manufacturers are the most "close fisted" concerning the operation, mixtures, etc.

From good authority we have knowledge of Indian steel (or "wootz") made in Persia and India between 500-400 B. C. by a method similar in theory to the crucible process of today; and from this steel were made the famous Damascus blades. About the middle of the eighteenth century Benjaman Huntsman invented the crucible cast steel method in England. In the United States we have record of the crucible plant as early as 1818 at Valley Forge, Pa., but the manufacture of good grades can be credited to Hussey, Wells & Co., Park Bro. & Co., and Gregory & Co., in the years 1860, 1862, 1863 respectively.

For purposes where a cutting edge, wearing quality or shock resistance is desired, or small castings of great strength wanted, there is nothing equal to crucible steel, and alloy steels have reached a point of efficiency for cutting, etc., to which no other product can be compared.

And yet the process is simply one of remelting scrap or good iron, Swedish, Norway, or American (according to grade) with the metalloids necessary to give it the desired qualities. The early method was one of imbedding the crucible or pot in a bed of fuel, but since the regenerative furnace was invented this method is alone used—producing the highest heat (except Thermit) used in the iron art—2,900 degrees F. in the melting hole.

For the working and detail of the crucible furnace the 24-pot, or 4-hole one, will serve all purposes, though this size is being replaced by the 5-hole, the latter producing a larger output at very little increased melting expense. The plan, or top view, of such a furnace is shown in Fig. 1.

Natural gas is used in some regions as the fuel, though without doubt producer gas is most widely known, as there is no danger of a sudden cessation of the source or a liability of irregular supply if properly manipulated.

The producer is set as near the furnace as practicable, and is the means of turning coal or other solid fuel into its gaseous components by partial combustion. The essential requirements of a producer being: complete combustion of the solid carbon; gas of uniform quality; continuous operation, and ease of same. The value of the gas as a combustible depends on the method of gasification and nature of fuel. If complete combustion took place the gas would be carbonic acid (CO_2), and water (H_2O), with nitrogen (N) and some oxygen (O) of the air supply, a non-combustible product.

And right here is the one great advantage of the use of gas rather than direct firing, for the vaporization, distillation and gasification evolve a combustible gas which can be burned in chambers to give a fuel value and high temperature otherwise impossible to attain.

CO 22.0 to 30.0 per cent carbone monoxide—calorific power =2400
O trace to 0.4 per cent oxygen
C_2H_4 trace to 0.4 per cent ethylene—calorific power =11858
CH_4 1.5 to 3.0 per cent methane—calorfic power =13060
H 7.0 to 15.0 per cent hydrogen—calorific power =34460
N 54.0 to 60.0 per cent nitrogen non—combustible

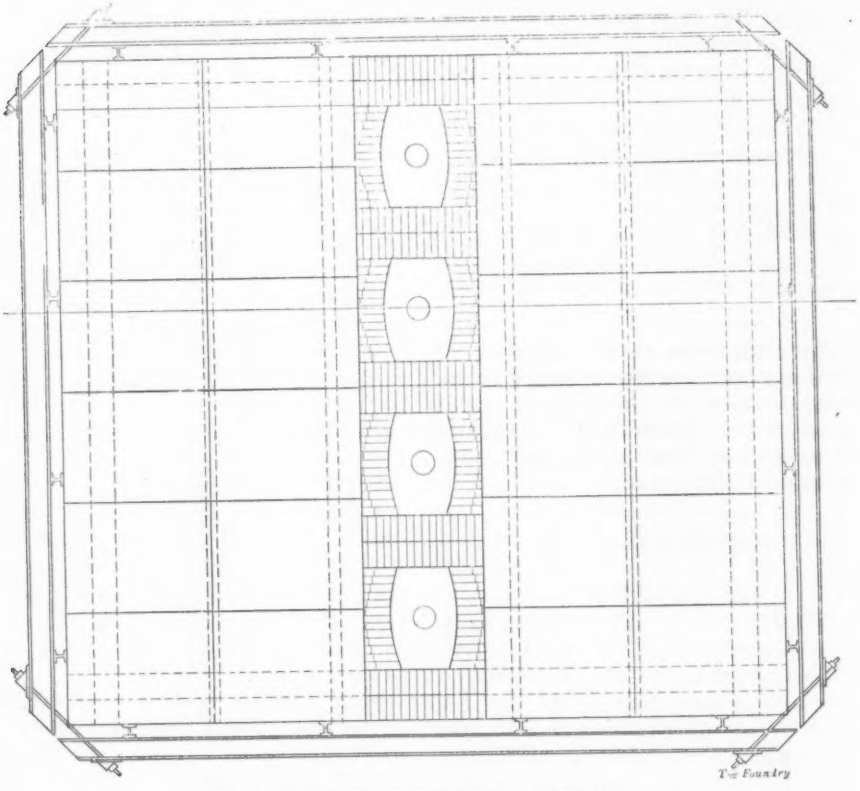


FIG. 1.—PLAN OF CRUCIBLE STEEL FURNACE.

A greater amount of heat is not obtained from the fuel, as the loss in calorific value varies from 15 to 25 per cent, but producer gas accomplishes the same result with less fuel and makes possible metallurgical operations impracticable by direct firing.

The accompanying sketch, Fig. 2, shows a typical producer as illustrated by R. D. Wood & Co., in their catalog, and while a great deal more may be said of the advantages of gas firing, its theories etc., it would require an article in itself.

An average analysis of producer gas will be of interest:

CO_2 1.5 to 6.0 per cent carbonic acid—non combustible.

To obtain the best results from a producer a good "gas man" is absolutely necessary, as the charging must be regular, any channels formed in the bed must be closed, driving not too rapid, fuel bed not too thin and the right amount of draught (air or steam) maintained. In fact the man must be one well trained in his line, so that by looking at the fuel bed he can at once tell the condition of the producer.

The average approximate yield of gas is 75 cubic feet per lb. bituminous coal, or 170,000 cubic feet per ton, of about 138,000 heat units per 1,000 cubic feet.

The gas is conveyed to the furnace by very wide flues, so constructed as to

reduce the flue pressure and loss of initial temperature to a minimum, since the gas pressure is not very great. The gas is admitted to the checker work by a valve controlling the amount, with another controlling the directions, i. e. the chamber into which it flows. Beside the gas valve is the air valve, so adjusted as to admit just sufficient air for complete combustion, and no more. The direction of the air is controlled by devices similar to those for controlling the air.

A person casually looking over a crucible furnace sees nothing unusual in its construction—an iron-covered floor about 26 feet by 22 feet, with a set of valves at one end, a pit for the molds on one side and a set of covered holes in the center. But let him go below. It is here he can see the checker work, the means of obtaining such an enormous heat.

On either side are two chambers in which are set the checker work: one row of brick laid lengthwise, the next crosswise, and alternately so almost to the top (see Fig. 3). These brick are highly refractory as they are subject to long intense heats.

The two inside chambers, about 16 feet long, 3 feet wide, 6 feet high are for gas; the outer set 16 feet by 3 feet, by 7 feet, are for air. When the furnace is first fired no perceptible heat is apparent, the air and gas mixing and burning in the holes, the warm products of combustion giving up part of their heat to the opposite checker work as they pass out. At the end of thirty minutes (when not melting) the action is reversed, the warmed checker brick giving up heat to the gas and air supply, which in turn give up heat to the other set. This constant reversing and increase of temperature (to the point desired) gives the regenerative characteristic to the furnace and produces the great heat. In many plants the warm gases are further utilized by being passed under boilers, etc. When melting the action is reversed every twenty minutes, allowing the brick no time to cool.

The gas and air enter the holes by three ports on either side, two (the end ones) for air, and the middle one for gas, combustion taking place on the union of the already heated gases. The ports are at the bottom, and built to slope upwards from the furnace, thereby preventing any molten steel from running into the checker brick.

The hole is about 2 feet 6 inches by 3 feet 6 inches at the top, sloping out-

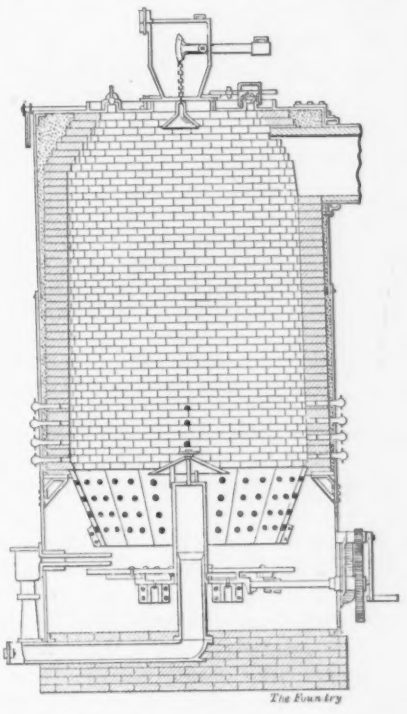


FIG. 2.—GAS PRODUCER WITH REVOLVING BOTTOM.

wards for about 18 inches, where it is about 3 feet by 3 feet 6 inches of a total depth throughout of 3 feet 6 inches. This space is sufficiently large to hold two rows of three crucibles each. The bottom is an iron plate (with a hole about 8 inches in diameter, in the center) covered with fire brick, on which is put crushed coke as the bottom for setting the crucible on. The general construction of the hole is shown in Fig. 4.

The hole in the plate, while melting, is covered with a cap which is removed at the end of every three heats (more frequently if necessary) and the refuse, scrap, etc., knocked into the pit below (see Fig. 3.), where all steel is picked out and remelted.

The covers for the holes are made of fire brick set in an iron frame, manipulated by a traveling bar with hook arrangement to swing same on or off.

The parts of the furnace subject to greatest heat must be built of the best refractory brick obtainable, the writer's experience having been that silica brick ite without a doubt being superior to any other. These are made in sizes to hold 80 to 120 pounds to a charge, the average being of 100 pounds capacity. The dimensions of crucibles for steel melting are about 8⅝ inches diameter at the top, 11 inches at belly, 7¾ inches at the bottom and 15 inches high, and made without lips.

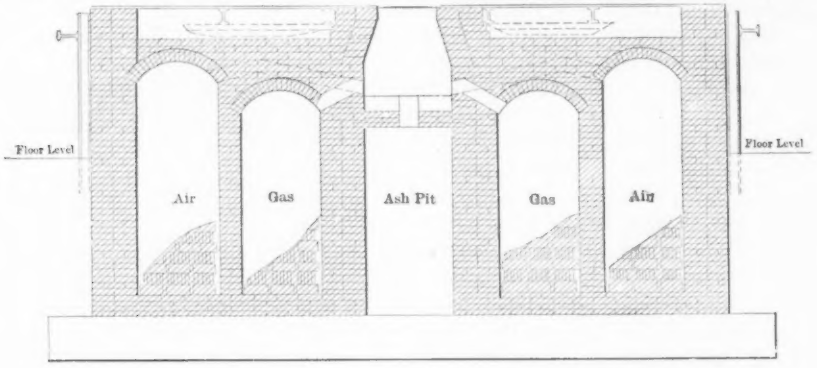


FIG. 3.—CROSS SECTION OF FURNACE SHOWING PORTS AND CHECKER WORK.

give much better results, although great care must be exercised in the initial firing and subsequent working of the furnace.

As stated above this process is one of remelting with the addition of metalloids to give the desired quality.

Arranged conveniently in the shop are the shears for cutting the scrap and muck bar into pieces of proper size to pack in the crucible. From the shears this raw material is stored in bins, each bin labeled as to contents. The weighing-up floor is handy to these bins, and each charge is weighed in pans holding one hundred pounds, then wheeled from the platform to the furnace floor, where the crucible is filled.

Close to the furnace is the "medicine" room, where the alloys, charcoal, manganese, chromium, tungsten, etc. —usually packed in with the charge of iron, are weighed into buckets. This medicine room is closely guarded, and in many plants the man who does the "doctoring" is ignorant of what he is putting up—so many ounces of No. 1, three pounds of No. 5, etc., for very few firms desire their mixtures known, although the properties of each alloy are familiar to all metallurgists.

The crucibles are clay or graphite, i. e. clay, graphite and sand, the graph-

The crucibles are filled either hot or cold, practice showing that a crucible filled hot (after pouring) will have a longer life than a cold-filled one. A first class pot should last on an average of four heats, some occasionally going as high as seven and others but one and two.

The filled crucibles, covered with caps, are placed in the furnace, where it takes from 2¾ to 4 hours to melt, depending on the charge (per cent of carbon), condition of furnace, and age of crucible (new, first or second heat, etc.). When melted the steel is "boiled" or "killed" for twenty or thirty minutes to insure thorough mixing and expulsion of excess gases.

Of late a system of charging and pulling by cranes has been devised, but even today the majority of "puller outs" are men with tongs, one of the hottest jobs in the iron industry.

The puller-out wears hob nail shoes, an old pair of trousers, an "apron," an old shirt, hand bags and in some cases blue glasses to protect his eyes. After thoroughly soaking himself with water, he straddles the open hole, one cover only, being off; protects his face with his hands, grips the pot, pulls it and rolls it to the molds. It is a very

quick operation, but let us see how much he lifts at over about 2,300 degrees of heat. The crucibles will average 30 pounds, the cap 5, 98 pounds of molten steel and the tongs 15 pounds,—a total of 148 pounds.

The molder has his molds placed in position in the pit, securely clamped and well smoked, leaning at such an angle as to make the pourings as easy as possible. The pot, skimmed by the molder, is now ready to pour—if pouring a 4-inch ingot the teemer must direct the stream down a three foot mold four inches square without hitting the sides, for if he does the mold is cut, a rough ingot results and the mold is probably ruined. Such a position requires a strong man of steady nerves.

A common practice in casting larger size ingots, up to six hundred pounds, is to take an old crucible, cut a small round hole in the bottom and pour through this, the melter and the puller-out alternately emptying the crucibles as they are rolled from the furnace. But on heavier ingots a regular pouring ladle is used, filled from the single crucibles.

Small ingots were for a long while the cause of much loss, return scrap and fuel waste, especially in high carbon steel, owing to "piping." The ingot cools from the outside, the contraction being inward and downward, thus forming a hole where the liquid metal on top has drawn away. Of course when the ingot is hammered or rolled this pipe causes a defect, and must be cut off to the solid steel, often necessitating a return of 25 to 35 per cent of scrap. Many methods have been devised for obliterating this loss, but the best and cheapest is a common clay pipe to fit in the mold, a cone built on a square bottom. The mold is almost filled, the pipe, warmed, set square end on the steel and the remaining metal poured through this; producing a solid ingot and giving a round solid chunk on the end—easily knocked off, good scrap, no loss after being worked and a fracture for reading carbon.

Small ingots are easily handled. When set in the mold they are removed to the cooling pit and fractured for grading. Ordinary steel containing nothing but the usual impurities can easily be judged by fracture, one experienced in that art being able to estimate the carbon contents (basis of classification) within .05 per cent either way.

The appearance of the fracture varies as the hardness: soft steel has a bright and finely granular surface, whereas

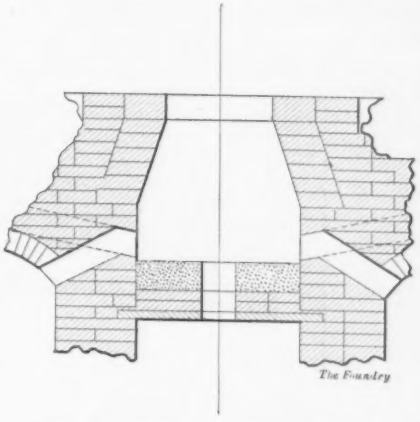


FIG. 4.—SECTION OF MELTING HOLE.

the harder tempers have distinct crystalline plates running parallel at right angles to the surface of the molds. Thus in a square mold, the most generally used, they tend to form a cross.

If uncertainty exists, or a desire to be checked, the piece broken off is sent to the laboratory for chemical analysis.

When marked by the firm's system of grading the ingots are piled in the store yard or carried direct to the rolls or hammers. The mark usually runs from a high number (representing the lowest carbon) to one, the highest carbon with letters to denote grade:—as, T-3, regular stock of 1.01-1.10 C; XX-4, extra special stock .81-.90 C. It is only in very high or unusually low carbon that one is liable to become confused by the fracture.

The ingots are worked either under the hammers or in the rolling mills until of desired size and shape, common steel requiring only ordinary care in treatment. But self-hardening and high speed steel must be manipulated

and handled with extreme caution.

Ingots of the latter class are subjected (in a heating furnace by radiation) slowly to bright red, soaking until the mass is thoroughly heated. It is then worked rapidly, with ease at such a heat (about 1,800 deg. F.), until cooled to a medium red, when reheating should take place, which can be done with more rapidity than the initial heating. When reduced to the desired form the steel should be cooled slowly and nicked for breaking while hot.

If such grade of steel is worked too cold or without thorough heating it will break and crumble under the blows. For rolling the same mode of procedure is followed. Such steels are usually slowly cooled to about 1,700 deg. F., then quenched in oil baths or the tool inserted in a cavity in a lead block until cold. Each manufacturer of high speed and self hardening steels has his method of treatment, and this is one branch of the crucible process which has been well written up for publication.

Each year shows improvements in steels, different percentages of alloys used and introduction of new elements beneficial to high grade steel, so the following mixtures will be given simply as an idea of the constituents of the various grades.

Ordinary steel when heated and quenched hardens according to temperature subjected to and carbon contents, and is then capable of cutting according to composition of metals to be cut and hardness of tool, at certain low speeds until the temperature of friction impairs its capability. Such a point is from 450-500 deg. F.

But in high speed steel the tool is worked at a very high speed and maintains its cutting power up to 1,150 deg. F. And though its initial cost may seem exorbitant its cheapness cannot but be apparent to consumers.

Where charcoal is used it will be noticed a low and high amount are given,

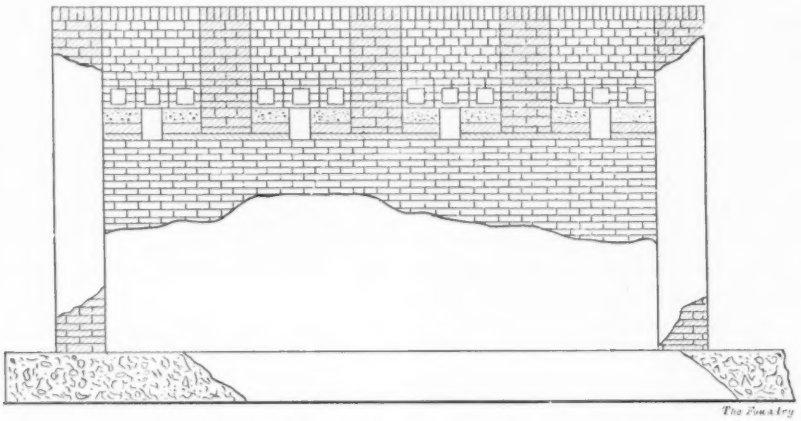


FIG. 5.—LONGITUDINAL SECTION OF MELTING HOLES, SHOWING LOCATION OF PORTS.

for new graphite crucibles give up carbon to the steel, but when old tend to absorb it—hence a provision for this action. An idea will also be obtained of the various kinds of scrap which may be used.

Punchings are those from soft boiler steel, a very pure article; muck when not otherwise designated, is the American bar iron; "miss" is a mixture, usually of low carbon steel from various sources; file is crucible file steel scrap, very high carbon; washed metal, a combination of almost pure iron and carbon (about 4.5 per cent); tool scrap, the common grade; and gummings, the scrap from the manufacture of saws.

The alloys mentioned contain the following percentages:—

Ferro-chromium 72 per cent chromium.

Ferro-manganese 80 per cent manganese.

Ferro-tungsten 80 per cent tungsten.
Metallic tungsten 98 per cent tungsten.
Ferro-molybdenum 80 per cent molybdenum
Ferro-silicon 50 per cent silicon.

Probably the cheapest made is file steel:—

Bessemer	30 pounds.
File	30 pounds.
Miss	40 pounds.
Charcoal	4-6 ounces.

A more expensive product for the same purpose is:—

Muck	20 pounds.
Punchings	35 pounds.
Miss	45 pounds.
Charcoal	10-14 ounces.
Ferro-chromium	2 ounces.

For an ordinary tool steel of about 1.00 per cent C the following was used:—

Washed metal	10 pounds.
Tool scrap	25 pounds.
Muck	50 pounds.
Punchings	15 pounds.
Charcoal	4-6 ounces.
Ferro-chromium	2 ounces.
Ferro-manganese	4 ounces.

The same grade but only of .70 carbon was:—

Punchings	10 pounds.
Washed metal	5 pounds.
Tool	15 pounds.
Gummings	20 pounds.
Muck	50 pounds.
Charcoal	2-4 ounces.
Ferro-manganese	4 ounces.
Ferro-chromium	4 ounces.

A special grade, made for dies, was:—

Muck	80 pounds.
Gummings	20 pounds.
Charcoal	10-14 ounces.
Ferro-chromium	3 ounces.
Ferro-manganese	5 ounces.
Ferro-tungsten	3 ounces.

A better grade than this was called "magnet," made from:—

Muck	60 pounds.
Punchings	20 pounds.
Tool	20 pounds.
Charcoal	6-8 ounces.
Ferro-manganese	5 ounces.
Ferro-chromium	1.5 pounds.

The "medicine" was packed with the charge and when melted five pounds of metallic tungsten was added.

Two mixtures for self hardening steel and two for high speed will be given. As before stated it is impossible to obtain the mixtures used in well known brands, but the company that used these turned out a fine grade.

Self hardening:—

Muck (Swedish)	50 pounds.
Tool (good grade)	30 pounds.
Washed metal	10 pounds.
Ferro-chromium	5 pounds.
Ferro-silicon	1.5 pounds.
Charcoal	8 ounces.
Ferro-manganese	4 ounces.

When melted 12 pounds of metallic tungsten is added and the steel put back in the furnace for one-half hour.

Self hardening scrap (8 per cent Wo.)	75 pounds.
Muck (Swedish)	25 pounds.
Ferro-tungsten	8 pounds.
Ferro-chromium	2 pounds.
Ferro-manganese	3 ounces.
Ferro-silicon	13 ounces.

For high speed:—

Muck (Swedish)	45 pounds.
Special tool scrap	40 pounds.
Washed metal	10 pounds.
Ferro-chromium	5 pounds.
Clay	4 pounds.

When melted the crucible is pulled, slagged and the following added:—

Ferro-silicon	1.5 pounds.
Ferro-manganese	8 ounces.
Metallic tungsten	20 pounds.
Flux	1.5 pounds.

The object of the clay was to act as a decarbonizer and it proved very efficient; but it would also remove the alloys, except chromium, to a large extent (probably by forming silicates) so these were not added until the clay was removed. The crucible is then replaced for thirty minutes.

The other mixture was:—

Muck (Swedish)	78 pounds.
Ferro-chromium	6 pounds.
Clay	8 pounds.

As in the preceding mixtures, the crucible was slagged and the following added:—

Ferro-manganese	10 ounces.
Ferro-silicon	1 pound.
Ferro-tungsten	11 pounds.
Ferro-molybdenum	6 pounds.

Crucible steel is used for many purposes besides those mentioned at first, the tempers and the use for which they are best adapted following:—

Carbon = 1.30 for files, small turning and planing tools, small cutters, razors, surgical instruments, drills, horse shoe

calks and plow edges; a temper requiring great care in heat treatment.

Carbon = 1.10 for heavy turning and planing tools, axes, drills and engraving instruments.

Carbon = .90 for bits, dies, large drills, reamers, cutters and circular saws.

Carbon = .80 for shear blades, chisels and taps.

Carbon = .70 for punches, smiths' tools, mining drills and screwing and minting dies.

Carbon = .60 for engraving plates, dies and hammers.

In calculating "medicine" for charges the charcoal is figured as the equivalent (in 100 charges) of .04 per cent carbon; and when molybdenum is used only one-half the amount is necessary as of tungsten.

It is these two alloys, tungsten and molybdenum, which give self hardening and high speed steels their characteristics—for the former grade 7-8 per cent of Wo. or 3.5-4 per cent Mo. is generally used; in the latter these percentages are about doubled.

Manganese and silicon are added in sufficient quantities to furnish the requisite strength—giving percentages; chromium produces great resistance to shock; and a small piece of stick aluminum is added by some melters to the metal just before pouring to quiet it.

It is a well known fact that nickel almost doubles the tensile strength of steel, but of its effects on the crucible product for other than strength purposes, very little is known.

Titanium, it is claimed, produces ductility and malleability in the steel, but as yet this remains to be proven, as this element seems to have little effect on carbon steels.

Experiments made with tin gave a brittle, hard material, the tin seeming to dissolve to form a compound with the iron. The carbon in steels containing not more than 10 per cent of tin has all the properties of pearlite.

We will now look at the cost of producing crucible steel—of course the raw materials fluctuate with the market, so no attempt will be made to calculate these, only an approximae cost of production.

The construction of a new furnace, complete, for twenty-four pots costs about $7,000.00, and a thirty-pot about $7,500.00; this includes furnace, stack, gas producer, floors, piping, retaining walls and foundations.

To produce gas sufficient for a twenty-four pot furnace—all figures will be on melting twenty-four hours or six heats—it requires about five and one-half tons of slack coal at about $2.10 per ton, $11.55 for the day or $1.92 per gross ton steel melted. Crucibles will average $2.00, and counting the life of each as four heats, the cost will be about $12.00 per gross ton.

Wages for furnace help vary according to location. A fair average for gas making will be $2.00, about $.70 per ton steel melted. The rate for melting at Pittsburg is $5.50 per ton. In addition to these expenses must be considered common labor, which may be put, including "medicine man" and weigher up, at $1.65 per gross ton; a total for labor, gas and crucibles of about $21.77 per gross ton, exclusive of wear on furnace.

In this paper very little mention has been made of castings, for the reason that a very small percentage of the crucible steel made is poured except as ingots, though each year shows an increase. In 1900, according to the U. S. Census Report, 104,393 gross tons were melted, of which amount only 3,643 tons, or not quite 3.5 per cent, were poured as castings.

The following figures are from the same source, a comparison of the output of the three principal steel methods, in gross tons:—

	Open-Hearth.	Bessemer.	Crucible.
1880	75,269	879,650	68,037
1890	480,035	3,617,198	73,882
1900	3,044,356	7,532,028	104,393

The production of crucible steel, according to the American Iron and Steel Association report, since 1900 was:—

1901	98,513 tons.
1902	112,772 tons.
1903	102,434 tons.
1904	83,391 tons.

One of the chief objects of this arti-

cle has been to give some idea of the inside of the manufacture of crucible steel, and if those who see the errors will enlighten the public along this branch of metallurgical art many will appreciate such work.

The Civil Engineers' Club, which is the largest engineering organization in Cleveland, has tendered the members of the American Foundrymen's Association and the Foundry Foremen's Association the privileges of their club rooms during the convention and have appointed a reception committee to co-operate with the Foundrymen of Cleveland in entertaining the guests at the convention.

A HANDY MOLDING MACHINE.

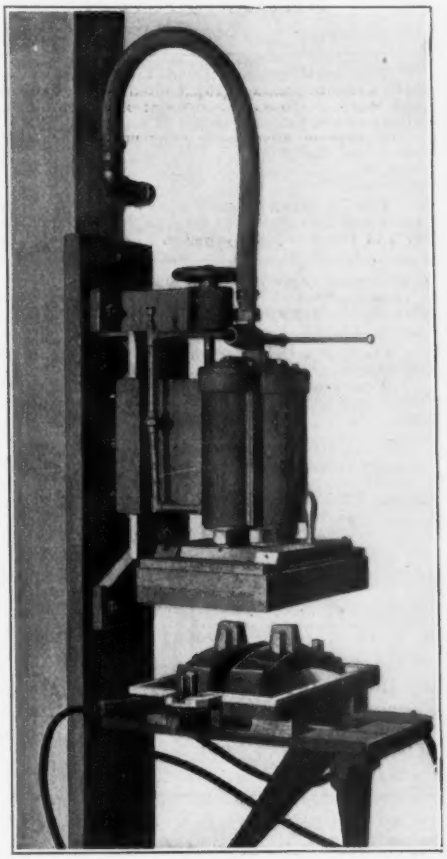
There is a large class of molding machine work which can only be done to advantage on an inexpensive machine, which can be quickly adjusted or changed from one pattern to another and from one depth of flask to another. To meet this requirement the machine must be substantially constructed, but must not be excessively expensive. It is also advantageous to have the machine so constructed that it can be used for ramming bench work or for ramming work on small hand ramming molding machines.

The accompanying illustration shows a machine especially designed to accomplish this purpose. It is mounted upon a 2 x 12-inch oak plank, which can be secured to any suitable post. The ramming head proper is mounted on an upright guide and secured to the guide by six clamping screws. When changing machine for a different height flask, these clamping screws are released and the head moved up or down by means of a screw, controlled by the hand wheel shown at the top.

The hard-wood ramming block is controlled and operated by three parallel cylinders, the center cylinder being six inches in diameter and the side cylinders three inches each.

The mechanism can be adjusted to simply squeeze the mold or to strike a blow, as requirements may dictate.

As ordinarily furnished, a long, rigid table is secured below the machine. This table is made long enough so that, after ramming, the mold can be drawn forward and rolled over. A



A HANDY MOLDING MACHINE.

knee valve is secured to the table for operating the vibrator. When desired, the table can be removed and a small hand ramming or stripping plate molding machine run under the ramming block and used in conection with it.

The Fuller Combing Gin Co., Charlotte, N. C., wish to receive catalogs of machinery and equipment for foundry and machine shop. They are especially interested in machine molding.

THE FOUNDRY

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TRADE OUTLOOK.

The foundry trade outlook in general is very good indeed, especially in the light gray iron foundry branches. A man who has had opportunity for wide observation among the heavy gray iron interests states that a large portion of the contracts now in the heavy shops is being made very close to cost, or at an actual loss. He attributes this to two causes: first, to the keen competition which has forced foundrymen to figure as closely as possible in order to secure the work. In this close figuring many have neglected to take into account the minor increases in expense which have occurred along many lines and are always inevitable in good times. The other reason is on account of the fact that many foundrymen fail to include all items of expense when figuring on a job. In the case of a heavy casting, the cleaning up of the wreckage, breaking up or storing of the rigging, clearing away of the brick work, and restoration of the foundry floor to working condition, frequently cost a large sum, and this is not always taken into account in figuring the price of the work. Then, too, a large job keeps an unusually large floor area tied up and should have a proportionally large amount of the fixed expense charged to it. Foundries which take account of all these matters will not accept work unless it can be obtained at a profit.

The writer visited one large foundry recently and the metallurgist in charge said, "The best thing about that big pile of castings" (referring to the stock banked up at the head of the machine shop) "is that every job was taken at such a figure that there is some profit in it."

The light gray iron foundries are especially busy and many of them making good profit, though even in some branches of the light gray iron work prices are exceedingly close and it is only by producing a large tonnage that a fair profit can be obtained. The steel casting foundries and the malleable foundries are both busy, though in some branches of each, prices are close.

The pig iron situation has not changed much since last month, though one interesting factor has to be taken into account. As spring approached, the stock of Bessemer ore available for certain furnaces in the valleys above Pittsburg became exhausted and the furnaces had either to be banked or switched onto foundry grades. To keep the furnaces going they have secured ore suitable for making foundry iron, and as a consequence, two furnaces are reported to be offering iron at $16.50 for No. 2 foundry at valley furnaces. Other interests, however, still hold to the price of $17.00 per ton for this grade, and the factor referred to cannot last many months as a supply of Bessemer ore will soon be available.

The ore freighters are already in commission and the first cargoes have been received at the lower lake ports.

No. 2 southern iron is now quoted at $14.00 per ton Birmingham and the southern interests are particularly busy. There have been several sales of heavy tonnages, both of northern and southern iron, during the past month.

You will receive a hearty welcome when you meet us at the convention in Cleveland next June.

Pompeian Castings.

When we secured the information and photographs for the article entitled "Some Old Bronze Castings," we little dreamed that Vesuvius would again be active before the article appeared in print, but the recent eruptions in Italy make this article of more than usual interest.

American Foundrymen's Association Convention.

We are glad to report that matters are progressing very nicely indeed toward the arrangements for the American Foundrymen's Association convention. A good list of papers has been secured, covering a wide range of foundry and pattern shop topics, and this insures a good program.

The entertainment features will be well taken care of. They will probably consist of a boat ride on the lake one night, an automobile ride through the parks one afternoon, and various evening entertainments, including a reception and a smoker. Special arrangements are being made to entertain the ladies and it is hoped that there will be a large attendance, as the Forest City has much of interest for the ladies as well as for the foremen. There will be visits to some of the largest industries in Cleveland.

The sessions will be held in the Central Armory, which is located two blocks north of the Hollenden Hotel, where many of the members will undoubtedly stop.

As announced last month, there will be an exhibit of foundry supplies and equipment in connection with the convention, and this exhibit will undoubtedly be the finest exhibit of foundry equipment that has ever been brought together. The exhibits will be arranged as a rectangle about the space occupied by the convention. The advantages of this are that the supply men will not feel that they have to stay at their exhibits during the convention sessions, while, on the other hand, the exhibits will not draw people away from the sessions.

We are hearing every day of more people who are planning to come, and it is evident that this is going to be the best attended convention that the Association has ever held. Any foundryman cannot derive as much benefit from the convention by sending a substitute as he would derive by attending himself. There are certain matters which can be talked over between the foremen much more freely and advantageously than between managers, and in like manner the managers, by meeting, comparing notes, and talking over matters, will be the gainers. Each sees all the foundry problems from his own angle, and the best results are only attained when both manager and foreman attend.

Associated Foundry Foremen's Convention.

The convention of the Associated Foundry Foremen will open on June 3, that is, one day in advance of that of the A. F. A.

The business session will probably be held Monday night, and during the balance of the week the sessions will alternate or be joint sessions.

The foundry foremen are preparing a fine list of papers, and it is evident that, as usual, they will take an active interest in the convention. Every progressive foundryman who possibly can do so should see that his foreman is present at the convention, in addition to attending himself.

We understand that the various local foremen's organizations are going to be very well represented at the convention and we will be glad to welcome them.

Special features have been prepared for the entertainment of the ladies who attend the convention, and it is hoped that a large number will be present.

ASSOCIATIONS AND SOCIETIES.

New England Foundrymen's Association.

Fred F. Stockwell, Secretary, Care of the Barbour-Stockwell Co., Cambridgeport, Mass.

The regular monthly meeting of the New England Foundrymen's Association was held at the Exchange Club, Boston, April 11. President Walter B. Snow in the chair. Dinner was served at six o'clock after which the routine business was disposed of in the usual manner.

Applications were received from the Sessions Foundry Co., Bristol, Conn.; A. F. Nichols, Lowell, Mass. and Charles H. Bird, Boston, Mass., and they were unanimously elected to membership.

Ex-President B. M. Shaw, who was one of the delegation that visited the Pittsburg Foundrymen's Association, made a report covering the many interesting points visited by the party. The delegation was particularly pleased with the hospitality of the Pittsburg Association and the thanks of the delegation and the association as a whole were extended to the Pittsburg Association for the invitation and entertainment.

Discussion was then thrown open regarding places of interest that the association could visit at its next regular meeting. The name of the Providence Steel Casting Co., of Providence, R. I., was suggested and the chairman appointed Mr. Chas. T. Colvin to confer with the proper officials and ascertain what arrangements could be made to visit their plant.

The president then introduced as the speaker of the evening, Prof. Albert Sauveur, of Boston, who addressed the meeting on the subject "Relations between Cast Iron and Its Structure," illustrated by stereopticon. At the conclusion of the remarks, a unanimous vote of thanks was extended to Mr. Sauveur.

Philadelphia Foundrymen's Association

Howard Evans, Secretary, care J.W. Paxson Co.

Plans for inviting the American Foundrymen's Association to hold its 1907 convention in Philadelphia, were discussed at the monthly meeting of the Philadelphia Foundrymen's Association, which was held on April 4, at the Manufacturer's club in that city. Secretary Evans called the attention of the members to the annual convention of the American association, which is to be held in Cleveland in June, and after pointing out the importance of the convention and urging as many members as possible to attend, brought up the question of inviting the association to hold its gathering next year in Philadelphia. Mr. Evans stated that it was ten years ago, in 1896, that the national body had been formed in the very room in which the local organization was then meeting, and thought that it would be an excellent idea to have the association return to the city of its birth.

When the matter was thrown open for discussion brief speeches in favor

of inviting the association were made by President Devlin, Dr. E. E. Brown, George C. Davis, Thomas Evans, Cyrus Borgner, George C. Davies and others, and it was decided by a unanimous vote to extend the invitation at the Cleveland convention. A resolution was also passed for the appointment of a committee of seven to formulate plans for entertaining the delegates, of whom it was estimated there would probably be 400 or 500, including the Foundry Foremen's Association. The announcement that the Philadelphia association has $2,422 in its treasury, with no debts, showed that it is in excellent condition to play the role of host.

The technical feature of the meeting was a paper by Arthur Lymington on "Molding Sand and Mold Wash for Steel Castings." This was followed by a humorous and poetical account by Dr. E. E. Brown of the trip to Pittsburg of 32 members of the association and friends. Leaving Philadelphia on Sunday night, April 1, the party reached Pittsburg the next morning and spent the day in visits to the Westinghouse and Homestead plants, the Carnegie technical schools and other points of interest.

Pittsburg Foundrymen's Association.

F. H Zimmers, Secretary, Care Union Foundry and Machine Co., West Carson Street.

The Pittsburg Foundrymen's Association's meeting, held on April 2, will long be remembered, not only by Pittsburg foundrymen, but by the many visiting members.

The Pittsburg foundrymen invited the members of the New England Foundrymen's Association, the Philadelphia Foundrymen's Association, together with representatives from Buffalo, Erie and Cleveland, to attend a special meeting on the second.

The contingent from Buffalo, Erie and Cleveland came straggling in on Sunday and Monday. The eastern forces came in a special car, arriving in Pittsburg at eight o'clock in the morning, where they were met by the Pittsburgers and the other guests who had already arrived.

The party were taken by special car to the foundries of the Westinghouse Machine Co., at Trafford City, where the morning was spent very enjoyably looking over the mammoth plant, including foundries, pattern shop and pattern storage. Mr. W. A. Bole, works manager of the Westinghouse Machine Co., met the party and personally conducted them through the works.

After a thorough inspection of the plant, the party boarded a train on the railroad owned by the Westinghouse company, and were taken to East Pittsburg, where lunch was served.

After lunch, trolley cars served to transfer the foundrymen to Homestead, where they were met by the representatives of the Carnegie Steel Co. and conducted through the works. The members were especially interested in the open-hearth furnace department and in the steel roll casting department.

After three hours of sight seeing, the electric cars were again boarded and the Carnegie Technical Schools visited. Special arrangements had been made to pour off the afternoon heat in the foundry at the time of the visit of the foundrymen. All of the departments of the school were visited. Mr. C. B. Connelley personally conducted the party through the schools, after Mr. Hammerslag, the director, had received them.

The electric cars then served to take the party down town to prepare for the evening.

At the banquet in the evening, President B. D. Fuller, of the Pittsburg association did the honors as toastmaster and with J. W. Wardrop, of the Merchants' and Manufacturers' Association, greeted the visitors. They decided that despite its dirt and smoke the city was the workshop of the world which assertion could be backed up with facts, and that under the pall from smokestacks and dust of furnaces the heart of the people were as warm, and they were as willing to extend the good hand of fellowship, as any in the city on the globe,

Thos. D. West, president of the American Foundrymen's Association, spoke on the coming national convention to be held at Cleveland in June. He said that while the association had already done great work, there was still much to do and that this required the co-operation of every foundryman in the country, that all must help and not as in the past let the work be one of patriotism when the burden fell upon a few. He explained that the Cleveland convention would excell any previous convention of the association and would provide unusual entertainment features, aside from offering an exposition by the foundry supply houses of the country.

E. H. Mumford, of Philadelphia, responded to the address of welcome in behalf of his Philadelphia associates and extended their hearty appreciation of the courteous entertainment provided by the Pittsburgers. B. M. Shaw, of Boston, responded in behalf of the New England delegation, and said that in that part of the country the impression prevailed that all Pittsburgers were millionaires and he was ready to believe it after the manner in which he had been entertained. W. B. Greene and H. M. Lane, of Cleveland, responded for that city, Mr. Lane talking upon the coming convention and making a plea for co-operation and a full attendance.

Prof. C. B. Connelley, of the Carnegie Technical School, spoke in appreciation of the assistance given the schools by the foundrymen and asked that they impress upon their young men the necessity of taking up a technical course. He said the good which has been done will be shown by the product turned out at the completion of the course.

Dr. R. Moldenke took up the educational side of the association's work, urged that those not already members be gathered into the fold and spoke of the recognition given the national association by the government in adopting standards for chemical analyses and the appointment of the association secretary as a member of a committee in connection with the United States Geological Survey.

Philadelphia Foundry Foremen.

W. P. Cunningham, American Bridge Co., Sec'y

The Associated Foundry Foremen of Philadelphia and vicinity held their sixteenth meeting on April 10, and the secretary reports that he believes it was at least sixteen per cent better than any previous meeting.

The members who attended the joint meeting in Pittsburg reported upon their trip. After this, there was considerable discussion upon the question of apprentices in the foundry; also upon the manufacturing of small steel castings.

Mr. W. P. Cunningham, secretary, had tendered his resignation, and hence John B. MacMeekin, of the Abram Cock Stove Co., of Philadelphia, was elected to fill the unexpired term.

Cleveland Foundry Foremen

H. M. Lane, Browning Bldg., Secretary.

The regular April meeting was held on April 7. One of the members had prepared a paper for presentation, but as there was considerable matter to be discussed concerning the coming convention and other matters of interest to be brought up, it was decided to carry the paper over to a special meeting to be held later.

After a general discussion of the matters relating to the coming convention, the matter of small cupolas was brought up and some very interesting experiences concerning the use of small or emergency cupolas were given.

All the members present agreed that they had received great benefit from these meetings, both in the way of exchange of ideas and also from the fact that they had become acquainted with the other foundry foremen, which acquaintanceship was not only pleasant, but also profitable.

Milwaukee Foundry Foremen.

Sol. Shaw, care Clinton Street Foundry of Allis-Chalmers Co., Secretary.

A very interesting meeting of the Milwaukee Foundry Foremen's Association was held on April 2.

The evening was given up to a gen-

eral discussion of the subjects of melting, molding and core making.

There was a large attendance and considerable interest shown in the discussion.

BUFFALO FOUNDRYMEN'S ASSOCIATION.
John E. Gorss, Secretary, 23 Builders' Exchange.

THE ASSOCIATED FOUNDRY FOREMEN.
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CHICAGO FOUNDRY FOREMEN.
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HAMILTON, ONT., FOUNDRY FOREMEN'S ASSOCIATION.
A. Chase, care Sawyer & Massey Co, Secretary and Treasurer.

BRITISH NOTES.

The Annual Convention of the British Foundrymen's Association is to be held during August Bank Holiday week, either at Newcastle-on-Tyne, Middlesboro, or Sheffield. The location is left for the time being undecided, to enable the promoters to find out whether any considerable number of engineering and foundry establishments will then be in operation. A material feature of the convention will be visits to works, and the choice will fall on the center which furnishes the largest number of works in operation. The program has not yet been arranged, but the gathering will be of an interesting character. Mr. Pilkington of the Sheepbridge Iron Works Chesterfield is the president-elect in succession to Mr. Buchanan, who has held the position for about 2½ years. Mr. Finch is likely to be re-elected secretary and treasurer, and it is agreed that he will well fill the position. The vice president has not yet been nominated. So far the program has yet to be arranged, but the papers will include one from Mr. F. J. Cook, manager for Messrs. Bellis and Moorcom, on the subject of "The effect of varying blast pressures on the quality of iron melted in the cupola." This is a subject which so far has not received adequate attention from practical foundrymen in this country, and it is understood that Mr. Cook has accumulated some very valuable facts and figures on the subject. Mr. Pilkington's election will be a popular one, as he is a gentleman of considerable standing in the trade and the holder of CE. and ME. with other distinctions.

At the beginning of the year the president, Mr. Buchanan, transferred his services from Messrs. Avery at Birmingham to the firm of Messrs. Chamberlin & Hill of Walsall of which establishment he is joint managing director. The firm has two establishments, one at Walsall and the other at Litchfield, and is of good standing, possessing an excellent reputation for light castings. During his presidency of the association Mr. Buchanan has witnessed a considerable growth in membership. This, even now, is not exactly imposing, as far as figures go, the total being from 110 to 115. But the membership may be said to represent the cream of the intelligence, and knowledge of the trade, and the proportion of employers and experts is very large. Although the society is still young, a remarkable number of testimonies have been received as to the practical usefulness of the combination to foundrymen. It is considered to have a great future before it.

The most important step recently taken has been the establishment of new sections for districts. Manchester has led the way, and the branch there is flourishing. Birmingham is now to follow suit, and a meeting for the in-

auguration of the new district has been fixed to take place at the Technical School on the 28th inst. when an address will be given by Mr. Buchanan. The subject will be "The Melting and Cooling of Cast Iron." This subject has been dealt with very acceptably by Mr. Buchanan at Leeds and Manchester. The May meeting has already been arranged, Mr. A. Hirons the head of the metallurgical department of the Technical School having agreed to give a paper. Then will follow the summer vacation. But it is intended to resume in earnest in October, and to have a paper at least once a month. It will be seen that the main business is to be the discussion of technical subjects, with the object of getting foundrymen thoroughly interested in the scientific aspect of their own work. The interest of those associated leaves nothing to be desired. Indeed the members "talk shop" when at the conventions morning, noon, and night in season and out of season, no doubt with great benefit to themselves, and fortunately their fellow-members are too much interested to be bored by their enthusiasm.

The firm of Messrs. J. & S. Roberts of the Swan and Small Heath foundries has completely ceased operations, and most of the plant has been sold. But within the last day or two an announcement has been made that the good will and trade name of the business have been sold to Mr. S. A. Roberts a son of one of the late proprietors. The price is said to have been £240. It is difficult to see what practical use the purchase can be put to, as all ironfounders agree that in view of the severe competition it will be impossible to run the establishment with any prospect of making a profit. Indeed the place is looked at askance throughout the trade, and no profitable work can be done without complete rearrangement of the works and practical reconstruction. The receiver and manager, Sir Walter Fisher, a well known Birmingham accountant has just announced that he has ceased to carry on trade except for the purpose of collecting outstanding debts.

One of the chief advantages derived from attending any convention is that resulting from the meeting of men who are thinking and working along parallel lines. The comparing of notes at these times and the renewing of friendships is always pleasant and profitable.

PERSONALS.

Alexander Nielson, of Sacramento, Cal., a member of the firm of Root, Nielson & Co., has sold out his foundry business and retired to private life, after over forty years of hard work. Before winding up the affairs of the company, Mr. Nielson entertained his old business associates and employes at an elaborate dinner. Toasts were responded to and a general good time enjoyed. The employes presented Mr. Nielson with a handsome gold watch and chain, to which was attached a charm of the Order of Odd Fellows.

Arthur Sweet, of Scranton, Pa., who was formerly employed at the Scranton Stove Works, has accepted a position as foreman at the Binghamton Stove Works, of Binghamton, New York.

Mr. Charles C. Knauss, who has been manager of the Allentown (Pa.) Foundry & Machine Works since 1900, has accepted a similar position with the Taylor Manufacturing & Construction Co., which has just completed a new plant at Allentown for the manufacture of mining, milling and concentrating machinery.

Mr. J. Gaffney, who has for some time been connected with the Allis-Chalmers-Bullock Co., Ltd., of Montreal, Canada, as foundry superintendent, has resigned his position to accept a position with the Dominion Foundry Supply Co., of Montreal, Canada. When Mr. Gaffney left his old position, he was presented with a handsome diamond ring, given by the officials and employees as a token of their best wishes and regard for him.

Frank H. Schutz, of Decatur, Ill., submitted three samples of alloys as an exhibition in connection with the exhibit of the H. Mueller Mfg. Co. at the Louisiana Purchase Exhibition in St. Louis. Mr. Schutz has been awarded a bronze medal for these mixtures.

R. H. Palmer has resigned the foremanship of the Derkins Machine Co.'s foundry at Warren, Mass., to accept a position as foreman of the foundry of R. Hoe & Co., Brooklyn, N. Y.

Wm. Hellig, of the firm of Willenborg & Hellig, Cincinnati, has resigned to enter the foundry business. The firm will hereafter be known as H. Willenborg & Son.

A. R. Lentz has resigned as superintendent of the Weatherby Foundry & Machine Co., to become superintendent of the Redmen Iron Foundry, Williamson Bros. Co., Philadelphia, Pa.

James Miller, superintendent of the Central Foundry Co.'s plant at Bessemer, Ala., since its organization, has resigned and has taken a similar position with the Bessemer Soil Pipe Co., in that city.

R. L. Riehl, former superintendent of the Star Foundry & Furnace Co., of St. Louis, has taken charge of the Sodeman Heat & Power Co., of Edwardsville, Ill.

W. M. Carr, who for the past two years has been connected with the Goldschmidt Thermit Co., of New York, has resigned his position and been appointed assistant to the president of the Commonwealth Steel Co., of St. Louis, Mo. Mr. Carr's broad experience fits him in a remarkable degree for taking a leading position in connection with steel foundry work.

Wm. A. Bole, because of his election as vice president of the Westinghouse Foundry Co., has resigned his position as manager of works of the Westinghouse Machine Co., though he continues with the latter as consulting engineer. He has been succeeded as manager of works by Harry L. Barton, formerly general superintendent of the East Pittsburg works of the Westinghouse company.

DEATHS.

Harry P. Haney, who was for twenty years foreman of the foundry at Roach's shipyard, Philadelphia, died on March 28. Mr. Haney was 70 years of age.

FIRES.

Fire of incendiary origin destroyed the foundry of H. W. Ollig, of Winthrop, Minn., on April 2. Loss, $7,000; insurance, $1,000.

The plant of the Henry Bonnard & Co. bronze foundry, at 430 to 444 West Sixteenth street, New York City, was damaged by fire to the extent of $500 on March 17. This is the plant in which Senator Clark is largely interested, he having acquired the plant to facilitate the turning out of the bronze castings and other art bronze work for his New York residence. The company have just completed a new foundry at Mount Vernon, N. Y., where the works will be moved by early summer.

On March 27, fire destroyed the boiler room, pattern shop and carpenter shop of the Aurora Foundry Co., of Aurora, Ill. The loss is estimated at $25,000.

The plant of the Garrison Foundry Co., of Pittsburg, Pa., was visited by fire on March 30, the damage amounting to $25,000. The principal loss is on patterns destroyed.

The foundry and several other buildings belonging to the Dean Gas Engine Co., of Cincinnati, Ohio, were destroyed by fire on March 29. Mr. A. G. Dean stated that the works would be rebuilt at once.

The plant of the Berres-Gehl Manufacturing Co., of West Bend, Wis., was almost totally destroyed by fire on April 12. The only buildings saved were the pattern house and store room.

The foundry of Taylor & Boggis and the H. C. Tack Factory, Cleveland, O., were damaged to the extent of $20,000 by fire on March 31.

J. N. Tallman & Son's brass foundry of Hamilton, Ont., was visited by fire on Feb. 27, resulting in a damage of $1,400.

Fire, caused by an explosion of gas in the plant of the United States Radiator Works at Dunkirk, N. Y., resulted in the destruction of one portion of the foundry, and it was only with great difficulty that the entire destruction of the plant was prevented. The damage is estimated at from $100,000 to $150,000.

The pattern shop of the Richmond Locomotive Works of Richmond, Va., was damaged to the extent of $5,000, on Feb. 16. The entire frame work of the building was burned and the machinery practically destroyed.

The pattern storage room and pattern department of the Liberty Iron Foundry of San Francisco, Cal., was damaged by fire on Feb. 15, with a loss of between $1,000, and $1,500. The fire was supposed to have originated from a spark from the cupola.

The foundry of Newell & Co., No. 1344 Buttonwood street, Philadelphia, Pa., was burned on April 7. The loss is estimated to be about $5,000.

NEW CONSTRUCTION.

Williamson Brothers Co. are planning to erect a two story addition to their foundry building, which will be 80 x 135 feet. The plant is located at Aramingo and Cumberland streets, Philadelphia, Pa.

Work is now in progress in the construction of a new foundry for the Scott Works at Reading, Pa.

The Light Manufacturing Co., of Reading, Pa., is having plans prepared for a pattern shop, 40 x 60 feet, together with some other additions to its plant.

The Allayne Brass Foundry Co., of Cleveland, O., will erect two additions to the Cleveland plant, one 36 x 48 feet and the other 24 x 28 feet.

E. H. Huenefeld Co., of Cincinnati, Ohio, has had plans prepared for a new two story foundry building, 100 x 350 feet.

The D. T. Williams Valve Co., of Cincinnati, Ohio, has purchased a lot on Hunt street and will erect concrete buildings to cost $125,000. One feature of the new plant will be a brass foundry for the manufacture of automobile trimmings.

The Aermotor Co., located at Twelfth and Rockwell streets, Chicago, Ill., has had plans prepared for a one story foundry building, 170 x 180 feet.

It is stated that the plant of the R. G. Denyes Machine & Tool Co., of Gray Lake, Ill., will have a large foundry constructed in the near future.

The National Sewing Machine Co., of Belvidere, Ill., will erect a two story addition to its foundry building, which will be 40 x 60 feet.

The Russel Wheel & Foundry Co., of Detroit, Mich., has completed plans for a new foundry building, 150 x 370 feet. This is to be equipped with three cupolas and modern appliances throughout.

Architect R. E. Raseman, of Detroit, Mich., has prepared plans for additions to the Capital Brass Works, of Detroit, which will consist of a foundry building, 50 x 134 feet, one story in height, and a finishing shop, 60 x 100 feet, two stories in height.

The Chicago, Milwaukee & St. Paul Railway Co. has had plans prepared for the construction of a new wheel foundry at West Milwaukee, Wis. The building will be one story in height and 161 x 368 feet. The cost, it is claimed, will be approximately $100,000.

Nelson Bros., Hutchinson, Kan., have let the contract for a small foundry to make the castings required in their pump and tank works.

The Utica Pipe Foundry, East Utica, N. Y., has begun the construction of four additional buildings, which will double the present capacity. One will be 115 x 225 feet, to be used as a foundry room. The foundry sheds will be 36 x 100 feet and a testing house and other small buildings will be constructed. A power plant may also be installed.

The Goulds Mfg. Co. of Seneca Falls, N. Y., has awarded the contract for the completion of its plant, which includes a foundry 114 x 500 feet, a power building, a pattern shop, cleaning room, etc.

The Cost of It

The expense of a modern system of cost-keeping need be no greater than a crude, antiquated and inefficient way of keeping accounts.

Such a system is accurate, quick and in ample detail, and it gives the detailed costs of every part of the work while the business is fresh—when it is most valuable as a basis of comparison.

We have studied cost-keeping very carefully and have installed systems which meet these requirements in many well-known foundries.

Will you accord us an interview?

GUNN, RICHARDS & COMPANY

Production Engineers and Public Accountants.....

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224 ST. JAMES STREET, MONTREAL

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Keeping up with the Procession

I am trying to "keep up," with the hope of getting ahead.

My East Indian Elephant recognizes the necessity of being on the "front seat" at all times and the plumbago he is bringing over fills the long-felt want you read about.

Its use gives pocket-book satisfaction to foundrymen all over the land.

The good appearance of a casting is not only easily produced with its use, but it is so produced with less cost, less quantity used, less labor on the mold, less labor in cleaning the casting, all of which is less strain on the pocket-book; hence, pocket-book satisfaction. Try a barrel at my risk.

The same element of quality pervades everything coming from my shop, and I have "Everything for a foundry."

FREDERIC B. STEVENS

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Curtis & Co. Mfg. Co., St. Louis.
Ingersoll-Rand Co., New York.
Norwalk Iron Works Co., So. Norwalk, Conn.

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Blackwell Sons & Co., Geo., Ltd., Liverpool, Eng.
New Era Mfg. Co., Kalamazoo, Mich.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.

Analysis—Mechanical:

Keep, W. J., Detroit.

Analysis—Chemical:

Metallurgical Laboratory, Pittsburg.

Anchors:

Lindsay & Co., W. W., Philadelphia.

Babbitt Metal:

Ajax Metal Co., Birmingham, Ala.

Barrels—Steel:

Kilbourne & Jacobs Mfg. Co., Columbus.

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Connersville Blower Co., Connersville, Ind.
Cornell Co., J. B. & J. M., New York.
Monarch Engineering & Mfg. Co., Baltimore.
Roots Company, P. H. & F. M., Connersville, Ind.
Sturtevant Co., B. F., Boston.

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Roots Company, P. H. & F. M., Connersville, Ind.
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Brushes:

Osborn Mfg. Co., Cleveland.

Burners (Oil):

Monarch Engineering & Mfg. Co., Baltimore.

Carbonese:

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Castings (Steel):

Otis Steel Co., Ltd., Cleveland.

Cement (Furnace):

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Cement (Metallic):

Clark Cast Steel Cement Co., Shelton, Conn.
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Smooth-On Mfg. Co., Jersey City.

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Fanner Mfg. Co., Cleveland.
Lindsay & Co., W. W., Philadelphia.
U. S. Chaplet Co., New York.

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Sellers & Co., William, Inc., Philadelphia.
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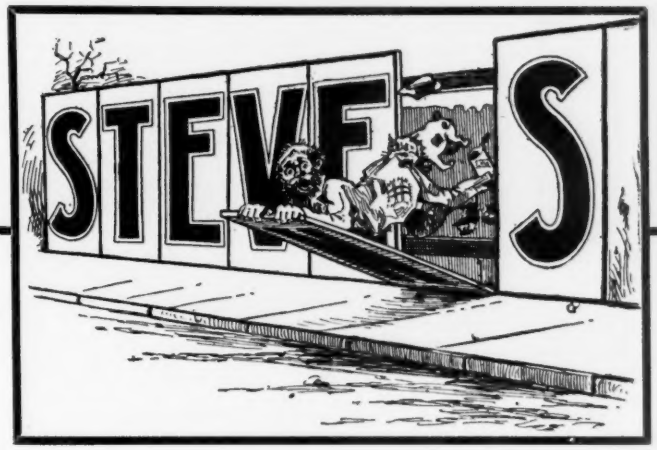

The Missing Letter

All the advertisements in this edition are in a way advertising my warehouse stock of Foundry Supplies. I carry them all—or nearly all—you can have quicker service and at just as low a price by buying them from me.

POLISHERS' AND PLATERS' SUPPLIES

I manufacture an entire line of polishing compositions—Tripoli, Crocus, Rouge, etc. These compositions are, from a practical point of view, the very best now on the market. The term "best" is a relative adjective, of course, and I use it in just that way, meaning that there is nothing so good offered today. If you will send that missing letter I will prove this statement.

BRASS FOUNDERS' SUPPLIES

There are several missing letters in my mail from Brass Founders who are in a hurry for supplies or who are not entirely satisfied with their present stock. Mail the letter and I will do the rest.

FREDERIC B. STEVENS

Corner Third and Larned Streets

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Waterbury Crucible Co., Waterbury.

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Obermayer Co., S., Cincinnati.
Paxson Co., J. W., Philadelphia.
Smith Foundry Supply Co., J. D., Cleveland.
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Obermayer Co., S., Cincinnati.
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Sly, W. W. Mfg. Co., Cleveland.
Stevens, F. B., Detroit.
Taylor, Robert J., Inc., Philadelphia.

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Obermayer Co., S., Cincinnati.
Osborn Mfg. Co., Cleveland.
Pangborn, Thos. W. Co., New York.
Paxson Co., J. W., Philadelphia.
Smith Foundry Supply Co., J. D., Cleveland.
Stevens, F. B., Detroit.
Taylor, Robert J., Inc., Philadelphia.

Furnaces (Melting):
Barnett Foundry Co., Oscar, Newark, N. J.
Hawley Down Draft Furnace Co., Chicago.
Monarch Engineering & Mfg. Co., Baltimore.
Paxson Co., J. W., Philadelphia.
Rockwell Engineering Co., New York.

Grinding Machinery:
Adams Co., Dubuque, Ia.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Norton Emery Wheel Co., Worcester.

Grinding Wheels:
Norton Emery Wheel Co., Worcester.
Pike Mfg. Co., Pike, N. H.
Superior Corundum Wheel Co., Waltham, Mass.
Vitrified Wheel Co., Westfield, Mass.

Grinding Pans:
Crossley Mfg. Co., Trenton, N. J.

Hammers (Pneumatic Chipping):
Ingersoll-Rand Co., New York.

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